FLORA DESMIDIARUM JAPONICARUM VII

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Auctore

Minoru HIRANO

Gen. **Cosmocladium** CORDA

in De BARY Conj. 77, 1858; RABENHORST Flor. Europ. Alg. 53, 1868; WEST & CARTER Monogr. Brit. Desm. 5, 197, 1923; SMITH Wisc. Bull. 57, 37, 1924; WEST & FRITSCH Treat. Brit. Alg. 282, 1927; PRINTZ ENGLER'S Pflanzenf. 3, 355, 1927; SMITH Freshw. Alg. U. S. 579, 1933.

Coloniae cum ramulis ellipsoidis vel sphaericae apud fascia gelatina ad sinum formantes, aliquando in gelatina hyalina matricale involtae; cellulae parvae cosmariiformes, compressae; chromatophoris axialibus, cum pyrenoidibus singulis in unaquaque semicellula; zygosporae globosae glabrae vel irregulares cum projectionibus latis angularibus.

1a. Cellulae modice constrictae, sinu depressioni; semicellulae globosae .... **C. constrictum**
1b. Cellulae profunde constrictae, sinu acuto aperto; semicellulae ellipticae .... **C. saxonicum**

Cosmocladium constrictum (ARCHER) JOSHUA in WEST & CARTER Monogr. Brit. Desm. 5, 198, 1923; HEIMANS Pflanzenf. 18, 116, 1935; YAMAGUCHI & HIRANO Act. Phytotax. Geobot. 15, 146, 1954.

Cellulae minutae, $1\frac{1}{3}$ longiores quam latiores, medice constrictae, sinu late aperto; semicellulae circulares; a latere et vertice visae circulares. Long. 14.6 μ, Lat. 12 μ, Lat. isth. 9.5 μ.

Hab. **Hondo**: Lake Biwa in Oomi. (Pl. LIII, fig. 9)

Distr. Japan, British Isles, Sweden, Finland, U.S.A.

Cosmocladium saxonicum De BARY in WEST & CARTER Monogr. Brit. Desm. 5, 202, 1923; SMITH Wisc. Bull. 57, 38, 1924; HEIMANS Pflanzenf. 18, 112, 1935; YAMAGUCHI & HIRANO Act. Phytotax. Geobot. 15, 146, 1954.

Cellulae parvae, leviter longiores quam latiores, profunde constrictae, sinu acute aperto et obtuso ad verticem; semicellulae ellipticae vel elliptico-reniformes; a latere visae circulares; a vertice visae ellipticae. Long. 22.8 μ, Lat. 17.2 μ, Lat. isth. 5.2 μ.

Hab. **Hondo:** Lake Biwa, Fuse-ike in Oomi. (Pl. LIII, fig. 10)
Distr. Japan, whole Europe, U.S.A.

Gen. Spondylosium BRÉB.

in KÜTZING Sp. Alg. 189, 1849; De BARY Conj. 76, 1858; WEST & CARTER Monogr. Brit Desm. **5**, 219, 1923; SMITH Wisc. Bull. **57**, 139, 1924; WEST & FRITSCH Treat Brit. Alg. 284, 1927; PRINTZ ENGL. Pflanzenf. **3**, 360, 1927; SMITH Freshw. Alg. U.S. 587, 1933.

Cellulae generaliter parvae vel modicae, modice vel profunde constrictae ad medium, sinu lineari vel aperto; semicellulae variabiles, ellipticae, oblongae vel triangulares, generaliter compressae, apicibus truncatis sine proccessibus apicalibus; membrana glabra vel punctata; chromatophoris axialibus cum pyrenoidibus; cellulis in filamentos longos conjunctis; zygosporae globosae, glabrae vel cum spinis simplicibus ordinatae.

1a. Cellulae in vertice visae ellipticae.
  2a. Sinu aperto excavato.
    3a. Semicellulae oblongae .... **Sp. planum**
    3b. Semicellulae ellipticae .... **Sp. ellipticum**
  2b. Sinu angusto-lineari.
    3a. Semicellulae reniformes .... **Sp. Lütkemülleri**
    3b. Semicellulae pyramidatae ....**Sp. pulchellum**
1b. Cellulae in vertice visae trigonae; semicellulae triangulares ... **Sp. moniliforme**

Spondylosium planum (WOLLE) W. & G.S. WEST in WEST & CARTER Monogr. Brit. Desm. **5**, 222, 1923; BORGE Ark. Bot. **23A**, 54, 1930; OKADA Journ. Imp. Fish. Inst. **30**, 192, 1934.

Filamentae non tortae, sed facile separatae; cellulae modicae, leviter latiores quam longiores, profunde constrictae, sinu late aperto rotundato ad verticem; semicellulae transverse oblongae, marginibus lateralibus bene rotundis, apicibus leviter convexis vel inflatis; membrana glabra; a latere visae circulares. Long. 8.4 μ, Lat. 8.4–12 μ, Lat. isth. 4.2–4.8 μ.

Hab. **Hondo:** Izu-numa in Rikuzen; Kurosawano-ike on Mt. Myoko in Echigo; Mt. Kazafuki, Shirouma-ôike, Tsuga-daira in Shinano; Mizoroga-ike in Yamashiro. (Pl. LIII, fig. 21)

Distr. Japan, Kuriles, Siberia, Europe, N. America.

Spondylosium ellipticum W. & G. S. WEST in WEST & CARTER Monogr. Brit. Desm. **5**, 222, 1923; YAMAGUCHI & HIRANO Act. Phytotax. Geobot. **15**, 146, 1954.

Cellulae parvae, leviter longiores quam latiores, profunde constrictae, sinu aperto, acuto et rotundato ad verticem; semicellulae ellipticae, apicibus paene rectis; a vertice visae ellipticae. Long. 28 μ, Lat. 21.5 μ, Lat. isth. 8.6 μ.

Hab. **Hondo:** Lake Biwa in Oomi. (Pl. LIV, fig. 3)
Distr. Japan, British Isles.

Spondylosium Lütkemülleri GRÖNBLAD in Bot. Notis. 65, 1938; YAMAGUCHI & HIRANO Act. Phytotax. Geobot. **15**, 146, 1954.

Cellulae parvae, leviter longiores quam latiores, profunde constrictae, sinu angusto-lineari ad verticem; semicellulae reniformes, apicibus valide convexis; a vertice visae ellipticae; a latere visae circulares. Long. 28 μ, Lat. 26 μ, Lat. isth. 7.7 μ.

Hab. **Hondo:** Lake Biwa in Oomi. (Pl. LIV, fig. 4)
Distr. Japan, Finland.

Spondylosium pulchellum ARCH. in REINSCH Contrib. Alg. Fung. 77, 1867; HUSTEDT Arch. Hydrobiol. **6**, 342, 1911; GRÖNBLAD Act. Soc. Faun. Flor. Fenn. **49**, 63, 1921; WEST & CARTER Monogr. Brit. Desm. **5**, 227, 1923; ALLORGE Rev. Alg. **5**, 368, 1930; IRÉNÉE-MARIE Nat. Canad. **76**, 41, 1949.

Filamentae non tortae, facile separatae; cellulae minutae, leviter longiores quam latiores, profunde constrictae, sinu angusto-lineari; semicellulae truncato-pyramidatae, marginibus lateralibus valide concavis, angulis basalibus rotundis, apice truncato et recto cum angulis apicalibus subrotundis; a latere visae subcirculares; a vertice visae ellipticae. 11-14 μ, Lat. 11-12.6 μ, Lat. isth. 2.8-4 μ.

Hab. **Hokkaido:** Sarufutsu in Kitami; Kamikoshi-ukishimahara in Ishikari. **Hondo:** Mt. Hakkoda in Mutsu; Ôyachi of Mt. Hachimantai, Yatsumanako of Mt. Iwate in Rikuchû; Mt. Komagatake in Ugo; Mt. Gassan in Uzen; Ozegahara in Kôzuke; Gakinotanbo, Mt. Eboshi in Etchû; Oku-ike of Higashi-kusano-mura in Oomi. (Pl. LIII, fig. 25)

Distr. Japan, whole Europe, Greenland, N. America, New Zealand.

Spondylosium moniliforme LUND. in Nov. Act. Regn. Soc. Ups. ser. 3, VIII, 92, 1871; SMITH Wisc. Bull. **57**, 141, 1924; YAMAGUCHI & HIRANO Act. Phytotax. Geobot. **15**, 146, 195[illegible].

Cellulae raro parvae, circiter $1\frac{2}{3}$ longiores quam latiores, profunde constrictae, sinu aperto et rotundato ad verticem; semicellulae triangulari-semicirculares, marginibus lateralibus inferioribus paene rectis, marginibus lateralibus superioribus convexis, apicibus aliquantulum elevatis et anguste rectis, angulis lateralibus rotundis; a vertice visae triangulares, lateribus valide concavis, angulis bene rotundis. Long. 32 μ, Lat. 19.6 μ, Lat. isth. 6.7 μ.

Hab. **Hokkaido:** Shimoyûbetsu in Kitami; Toyokoro in Tokachi. **Hondo:** Izu-numa in Rikuzen; Chûkawa-ike in Uzen; Akaiyachi in Iwashiro; Shinohara-ike, Fuse-ike, Lake Biwa in Oomi; Mizoroga-ike in Yamashiro. (Pl. LIV, fig. 2)

Distr. Japan, Sweden, U.S.A.

Gen. **Hyalotheca** EHRENB.

in RALFS Brit. Desm. 51, 1848; KÜTZING Sp. Alg. 187, 1849; De BARY Conj. 76, 1858; RABENHORST Flor. Europ. Alg. 151, 1868; WEST & CARTER Monogr. Brit. Desm. **5**, 228, 1923; SMITH Wisc. Bull. **57**, 141, 1924; WEST & FRITSCH Treat. Brit. Alg. 285, 1927; PRINTZ ENGLER'S Pflanzenf. **3**, 362, 1927; SMITH Freshw. Alg. U.S. 588, 1933.

Cellulae subcylindricae, levissime constrictae ad medium, sinu depressioni vel retuso; semicellulae trapezoides, subquadratae, marginibus lateralibus rectis vel leviter convexis, apicibus sine tuberculis vel projectionibus; chromatophoris axialibus cum pyrenoidibus singulis centralibus; cellulae in filamentos longos formantae, filamentis non tortis sed aliquando in vagina gelatinae matricalis involtae, ibi radialiter cum fibrillis; zygosporae globosae et glabrae.

1a. Cellulae generaliter tam longae quam latae, in vertice visae circulares.
  2a. Cellulae parvae, 6-9 μ in latitudinem; membrana glabra .... **H. undulata**
  2b Cellulae modicae, 16-22 μ in latitudinem; membrana serie transversali granulcrum ordinata .... **H. mucosa**
1b. Cellulae tam latae quam longae, aliquandin tam longae quam latae vel raro leviter longiores quam latiores, in vertice visae circulares, sed aliquae papillae 2-3 aequidistantae ordinatae.
  2a. Cellulae generaliter tam latae quam longae .... **H. dissiliens**
    3a. Cellulae in vertice visae circulares sine papilla.
      4a. Cellulae 10-20 μ in latitudinem .... var. **minor**
      4b. Cellulae 20-38 μ in latitudinem .... f. **typica**
    3b. Cellulae in vertice visae cum papilla.
      4a. Papillae duo .... f. **bidentula**
      4b. Papillae tres. .... f. **tridentula**
  2b. Cellulae paene longiores quam latiores vel paullo longiores quam latiores.
    3a. Cellulae 16-20 μ in latitudinem, sinu depresso .... var. **tatrica**
    3b. Cellulae 9-12 μ in latitudinem, sinu aliquando acuto .... **H. indica**

Hyalotheca undulata NORDST. in WOLLE Desm. U.S. 23, 1884; WEST Trans. Linn. Soc. Bot. **6**, 195, 1902; WEST & CARTER Monogr. Brit. Desm. **5**, 239, 1923; BORGE Ark. Rot. **19**, 44, 1925; ALLORGE Rev. Alg. **5**, 368, 1930; KRIEGER Arch. Hydrobiol. Suppl. **11**, 221, 1932.

Filamentae non tortae, facile separatae; cellulae parvae, circiter $1\frac{1}{2}$ vel duplo longiores quam latiores, emarginatim constrictae; semicellulae subcirculares, marginibus lateralibus convexis, apice truncato cum angulo rotundo; a vertice visae circulares; membrana glabra. Long. 8.4–10.8 μ, Lat. 5.6-6.4 μ, Lat. isth. 4.3–4.8 μ.

Hab. **Hokkaido**: Tomakomai in Iburi. **Hondo**: Ozegahara in Kôzuke;

Ko-ike in Yamashiro. (Pl. LIV, fig. 5)
Distr. Japan, Thailand, India, Ceylon, Sumatra, Europe, U.S.A.

Hyalotheca mucosa (MERT.) EHRENB. in RALFS Brit. Desm. 53, 1848; WEST Journ. Linn. Soc. Bot. **38**, 131, 1907; MIGULA Krypt. Fl. **2**, 558, 1907; WEST & CARTER Monogr. Brit. Desm. **5**, 235, 1923; DICK Pfälz Ver. Nat. Pollichia **3**, 142, 1930; ALLORGE Rev. Alg. **5**, 368, 1930; OKADA Journ. Imp. Fish. Inst. **30**, 193, 1934.

Filamentae non tortae, cellulae modicae, cylindricae, fere quadrangulares, circiter $1\frac{1}{3}$ longiores quam latiores, in medio levissime constrictae, marginibus lateralibus fere parallelis vel leviter convexis retusis autem in medio, apice truncato cum seriebus duabus granulorum minutorum subter semicellulam unamquamque; a vertice visae circulares. Long. 14–22.4 μ, Lat. 14–22 μ, Lat. isth. 13.7–21.5 μ.

Hab. **Hokkaido:** Tomakomai in Iburi. **Hondo:** Ôyachi, Naga-numa in Rikuchû; Moritake-ôtsutsumi, Aka-numa, Megata, Koke-numa in Ugo; Izu-numa in Rikuzen; Akaiyachi in Iwashiro; Kashima-cho in Iwaki; Happo-ridge in Shinano; Kotsutsumi-nishi-ike in Mikawa; Ishigaki-ike, Jôdo-ike in Ise; Lake Biwa, Fuse-ike in Oomi; Mizoroga-ike in Yamashiro; Ikejiri-ike in Tanba. **Shikoku:** Yamada in Tosa. (Pl. LIII, fig. 18, 19)

Distr. Japan, Kuriles, India, Europe, N. & S. America, Australia, central Africa.

Hyalotheca dissiliens (SM.) BRÉB. in RALFS Brit. Desm. 51, 1848; WOLLE Desm. U.S. 22, 1884, WEST Ann. Roy. Bot. Gard. Calcatta **6**, 225, 1907; SMITH Wisc. Bull. **57**, 142, 1924; WEST & CARTER Monogr. Brit. Desm. **5**, 229, 1923; OKADA Journ. Imp. Fish. Inst. **30**, 192, 1934

Filamentae longae non tortae, saepe vagina mucosa; cellulae mediocres, circiter $1\frac{1}{4}$–$1\frac{1}{2}$ latiores quam longiores, levissime constrictae, sinu depresso; semicellulae subtrapezoides, marginibus lateralibus convexis, apicibus latis truncatis; a vertice visae circulares; membrana punctata, punctulis subter medium ordinatis. Long. 14–22 μ, Lat. 23–32 μ, Lat. isth. 22–30.4 μ.

Hab. **Hokkaido:** Okineppe in Nemuro; Kiritappu in Kushiro; Nikuru-numa, Shimoyûbetsu, Furutoi, Sarufutsu in Kitami; Toyokoro in Tokachi; Numano-taira of Mt. Daisetsu, Horomui in Ishikari; Yûfutsu, Numanohata, Tomakomai in Iburi. **Hondo:** Mt. Hakkoda, Rokuzawa-tameike in Mutsu; Mt. Kanpu, Kawashiri, Mt. Komagatake in Ugo; Naga-numa of Mt. Hachimantai in Rikuchû; Ôishita, Hijiori-naganuma, Mt. Sugigamine of Zawo, Chûkawa-ike in Uzen; Bagyu-numa, Ojiroi in Iwaki; Nogiwano-kwannon-ike, Kôriyama, Hôzawa-ike, Akaiyachi in Iwashiro; Gôno-ike in Hitachi; Higusa-numa in Shimofusa; Inago of Kitamaki-mura, Kamikôchi, Karuizawa, Kizaki in Shinano; Hichimenzan in Kai; Tanuki-numa in Suruga; Ônuma, Takashihara, Suhara-ike, Kotsutsumi-nishi-ike in Mikawa; Tamaru, Toba, Kanashôzu in Ise; Fuse-ike in Oomi; Ariga-ike, Shakuhachi-ike in Yamashiro; Ikejiri-ike in Tanba. **Kiushiu:** Yabakei in Bunzen. (Pl. LIV fig. 11)

Distr. Japan, Kuriles, Siberia, central China, Thailand, India, Malay, Ceylon, Java, Europe, Nova Zembla, Spitzbergen, Greenland, N. & S. America, Australia, Africa, Azores.

forma **bidentula** NORDST. in Act. Univ. Lund. 9, 48, 1873; WEST & CARTER Monogr. Brit. Desm. 5, 232, 1923.

Cellulae in vertice visae circulares cum papilla utrobique ornatae. Long. 19.6–20 μ, Lat. 26–28 μ.

Hab. **Hondo:** Izu-numa, Kesho-numa, Kobuchi-numa in Rikuzen; Hakuryu-ko, Mt. Azuma in Uzen; Numano-taira on Mt. Bandai in Iwashiro; Oze in Kôzuke; Takayachi on Mt. Myoko in Echigo; Ashinota-ike, Midorigaike, Amaga-ike of Mt. Yatsugatake in Shinano; Nukigawa, Mt. Hira in Oomi. **Shikoku:** Sumiyoshi-ike, Yamada in Tosa; Matsuyama in Iyo. **Kiushiu:** Kôga-muta of Mt. Aso in Higo. (Pl. LIII, fig. 12, 13)

Distr. Japan, Burma, Europe, Spitzbergen, Greenland, Brazil.

forma **tridentula** NORDST. in Act. Univ. Lund. 9, 48, 1873; WEST & CARTER Monogr. Brit. Desm. 5, 233, 1923.

Cellulae in vertice visae circulares cum papilla 3 ornatae.

Hab. **Hokkaido:** Kiritappu in Kushiro. (Pl. LIII, fig. 14)

Distr. Burma, India, Europe, Spitzbergen, Greenland, S. America, New Zealand.

var. **minor** DELP. in WEST & CARTER Monogr. Brit. Desm 5, 232, 1923; ALLORGE Rev. Alg. 5, 368, 1930.

Var. minor, cellulae circiter tam longae quam latae vel leviter latiores. Long. 12.6–14 μ, Lat. 14.6–19.6 μ.

Hab. **Hokkaido:** Shikaribetsu-wopputo in Tokachi; Benten-numa in Iburi. **Hondo:** Mt. Iwaki in Mutsu. Moritake-ôtsutsumi, Hirumo-numa, Megata in Ugo; Ôishita in Uzen; Numano-taira on Mt. Bandai in Iwashiro; Nanko in Iwaki; Inago of Kitamaki-mura, Mt. Kirigamine in Shinano; Ishigaki-ike in Ise. **Kiushiu:** Koshiki-ike on Mt. Kirishima in Hiuga. (Pl. LIII, fig. 15)

Distr. Europe.

var. **tatrica** RACIB. in WEST & CARTER Monogr. Brit. Desm. 5, 234, 1923; OKADA Journ. Imp. Fish. Inst. 30, 193, 1934.

Cellulae circiter tam longae quam latae vel leviter longiores, quadrangulares, distincte constrictae; semicellulae circiter duplo latiores quam longiores, marginibus lateralibus convexis. Long. 14–22 μ, Lat. 14–20 μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Sarufutsu in Kitami; Horomui in Ishikari. **Hondo**: Mt. Hachimantai, Benze-numa in Mutsu; Hakuryu-ko in Uzen; Izu-numa, Naga-numa, Kobuchi-numa in Rikuzen; Bagyu-numa in Iwaki; Mt. Naeba in Echigo; Mt. Tateyama, Tarobei-daira, Kurobegoro-daira in Ftchû; Happo-ridge, Tengunohara, Tsuga-daira, Mt. Kirikamine, Daimon-pass, Shigakôgen, Kizaki, Karuizawa in Shinano; Tanuki-numa in Suruga; Kotsutsumi-nishi-ike in Mikawa; Tamaru in Ise; Fuse-ike, Oku-ike of Higashi-kusano-mura in Oomi. **Kiushiu**: Mt. Ôhatayama of Kirishima in Hiuga. (Pl. LIII, fig. 16)

Distr. Japan, Kuriles, Europe, E. Africa.

Hyalotheca indica TURNER in K. Sv. Vet. Akad. Handl. *25*, 152, 1893; WEST & CARTER Monogr. Brit. Desm. **5**, 237, 1923; OKADA Inkwa. 189, 1939.

Filamentae non tortae, cum vagina mucosa; cellulae parvae, leviter longae quam latae, subcylindricae, modice constrictae, sinu acutangulo et aperto; semicellulae angulari-subtrapeziformes, marginibus lateralibus convexis et convergentibus; apicibus late truncatis; a vertice visae circulares. Long. 14 μ, Lat. 14 μ, Lat. isth. 13.7 μ.

Hab. **Hondo**: Kurosawano-ike on Mt. Myoko in Echigo; Ô-numa in Mikawa; Ko-ike in Yamashiro. (Pl. LIII, fig. 17)

Distr. Kuriles, India, Ceylon, British Isles.

Gen. **Gymnozyga** EHRENB.

in WEST & CARTER Monogr. Brit. Desm. **5**, 254, 1923; SMITH Wisc. Bull **57**, 146, 1924; WEST & FRITSCH Treat Brit. Alg. 287, 1927; SMITH Freshw. Alg. U.S. 591, 1933.—*Bambusina* in PRINTZ ENGLER's Pflanzenf. **3**, 362, 1927.

Cellulae in filamentos longos conjunctae, saepe leviter tortae; cellulae cylindricae vel barreliformes, non compressae, paullo constrictae ad medium, apicibus truncatis; membrana glabra vel striata longitudine prope apicem et isthmum; chromatophoris axialibus cum pyrenoidibus centralibus; zygosporae ovales vel subglobosae, glabrae.

1a. Cellulae 19–21 μ in latitudinem .... **G. moniliformis**
1b. Cellulae 10–11 μ in latitudinem .... var. **gracilescens**

Gymnozyga moniliformis EHRENB. in BERNARD Dep. agr. Indes. Néerl. 23, 1909; WEST & CARTER Monogr. Brit. Desm. **5**, 255, 1923; KRIEGER Arch. Hydrobiol. suppl. **11**, 221, 1932; FUJISAWA Journ. Jap. Bot. **10**, 444, 1934; PRESCOTT & SCOTT Trans. Amer. Micr. Soc. **61**, 26, 1942.

Filamentae paullo tortae; cellulae seriatae, circiter duplo longiores quam latiores, medio leviter constrictae; semicellulae cum inflatione basali parva, marginibus lateralibus rectis vel leviter concavis, apicibus truncatis rectis cum angulis apicalibus leviter rotundis; membrana glabra saepe delicate striata, striae longitudinaliter ordinatae; a vertice visae circulares cum mamillata-projectione utrobique. Long. 26–28 μ, Lat. 19.4–21 μ.

Hab. **Hokkaido:** Kiritappu in Kushiro; Nikuru-numa, Sarufutsu, Furutoi in Kitami; Toyokoro-konuma in Tokachi; Mt. Daisetsu, Nopporo, Horomui, Minenobu, Kamikoshi-ukishimahara in Ishikari; Yûfutsu, Tôasa-numa, Tomakomai in Iburi; Shizukari in Oshima. **Hondo:** Mt. Hakkoda, Mt. Hachimantai, Benze-numa in Mutsu; Koke-numa, Nishi-numa, Megata, Moritake-ôtsutsumi, Mt. Kurikoma in Ugo; Mt. Gassan, Mt. Azuma, Hijiori-naga-numa, Ôishita, Chûkawa-ike, Mazawano-naga-numa in Uzen; Kesho-numa in Rikuzen; Nogiwano-kwannon-ike, Akai in Iwashiro; Hibushi-numa, Ojiroi in Iwaki; Oze in Kôzuke; Usagishima in Shimotsuke; Gôno-ike in Hitachi; Mt. Naeba in Echigo; Kumono-taira, Kurobegoro-daira, Tarobei-daira, Mt. Tateyama in Etchû; Mt. Kirigamine, Shigakôgen, Happo-ridge, Tengunohara, Tsuga-daira, Kizaki in Shinano; Takashihara, Kotsutsumi-nishi-ike in Mikawa; Ishigaki-ike, Jôdo-ike, Tamaru in Ise; Fuse-ike, Mt. Hira in Oomi; Mizoroga-ike, Ko-ike in Yamashiro. **Kiushiu:** Imuta-ike in Satsuma. (Pl. LIV, fig. 6)

Distr. Japan, Kuriles, Manchuria, Siberia, Burma, India, Ceylon, Java, Sumatra, Europe, Spitzbergen, N. America, Australia, New Zealand, E. Africa, S. America.

var. **gracilescens** NORDST. in WEST & GARTER Monogr. Brit. Desm. **5**, 257, 1923; PRESCOTT & SCOTT Trans. Amer. Micr. Soc. **61**, 26, 1942.

Var. angustior. Long. 22.4 μ, Lat. 10.4 μ.

Hab. **Hondo:** Ishigaki-ike in Ise. (New to Japan) (Pl. LIV, fig. 7)

Distr. China, Java, Ceylon, British Isles, Sweden, U.S.A., Brazil.

Gen. **Desmidium** AG.

in HASSALL Brit. Freshw. Alg. 341, 1845; RALFS Brit. Desm. 60, 1848; KÜTZING Sp. Alg. 190, 1849; NÄGELI Gatt. einz. Alg. 130, 1849; De BARY Conj. 76, 1858; WEST & CARTER Monogr. Brit. Desm. **5**, 240, 1923; SMITH Wisc. Bull. **57**, 143, 1924; WEST & FRITSCH Treat. Brit. Alg. 286, 1927; PRINTZ ENGLER's Pflanzenf. **3**, 361, 1927; SMITH Freshw. Alg. U.S. 590, 1933.

Cellulae in filamentos longos conjunctae, filamentis generaliter spiraliter tortis et saepe in vagina hyalina matricali involtis; cellulae saepe latiores quam longiores, modice constrictae; semicellulae generaliter trapezoides, apicibus truncatis vel valide concavis ad medium et amplitudo angusto-elliptico aperta inter cellulas conjunctas formantes; a vertice visae late ellipticae, triangulares vel quadrangulares; chromatophoris axialibus cum pyrenoidibus singulis vel plus; zygosporae sphaericae vel ellipsoides, glabrae vel papilla conica vel aliquantum recta praeditae.

1a. Semicellulae sine processibus apicalibus et foraminibus inter cellulam proximis.
  2a. Cellulae in vertice visae subcirculares cum papillis duabus opposite ordinatae, in fronte visae elliptico-hexagonae .... **D. coarctatum**
  2b. Cellulae in vertice visae trigonae, in fronte visae subrectangulares.. **D. Swartzii**
1b. Semicellulae cum processibus apicalibus et foraminibus inter cellulam proximis.
  2a. Foramina angusto-lineata, sinu profundo.
    3a. Apice lato .... **D. aptogonum**
    3b. Apice angusto .... **D. pseudostreptonema**
  2b. Foramina elliptica, sinu solum depresso .... **D. Baileyi**

Desmidium coarctatum NORDST. in K. Sv. Vet. Akad. Handl. **22**, 25, 1888; WEST Journ. Linn. Soc. Bot. **33**, 321, 1898; HIGASHI List Jap. Freshw. Alg. 283, 1916; WEST & CARTER Monogr. Brit. Desm. **5**, 252, 1923; KRIEGER Arch. Hydrobiol. suppl. **11**, 220, 1932; OKADA ASAHINA's Inkwa. 191, 1939.

Filamentae tortae; cellulae mediocres, elliptico-hexagonales, $1\frac{1}{2}$ latiores plus quam longiores, modice constrictae, sinu lineari vel acutangulo aperto; semicellulae primo gradatim et secundo rapide attenuatis versus apices, angulis basalibus acuto rotundis, marginibus lateralibus convergentibus, apicibus semicellularum leviter elevatis et dilatatis, circiter $\frac{1}{3}$ longius quam latius; a latere visae cellulae quadratae cum lateribus medio leviter retusis, polis elongatis dilatatis, apice recto; a vertice visae angusto-ellipticae, polis mamillato-protuberantibus. Long. 19.6–29.4 μ, Lat. 23–33 μ, Lat. isth. 16.8–23.8 μ.

Hab. **Hokkaido:** Kiritappu in Kushiro; Nikuru-numa in Kitami; Toyokorokonuma in Tokachi; Hisago-numa on Mt. Daisetsu in Ishikari; Yûfutsu, Tomakomai in Iburi; Shizukari in Oshima. **Hondo:** Benze-numa in Mutsu; Koke-numa, Hirumo-numa, Megata in Ugo; Chûkawa-ike in Uzen; Kesho-numa in Rikuzen; Nogiwano-kwannon-ike, Akai in Iwashiro; Hibushi-numa in Iwaki; Ozegahara in Kôzuke; Mt. Kaminotake in Etchû; Amaga-ike on Mt. Yatsugatake, Happo-ridge, Kizaki, Karuizawa in Shinano; Tanuki-numa in Suruga; Kotsutsumi-nishi-ike in Mikawa; Ishigaki-ike, Jôdo-ike, Tamaru in Ise; Fuse-ike, Mt. Hira in Oomi; Mizoroga-ike, Takaraga-ike in Yamashiro. **Shikoku:** Yamada in Tosa. **Kiushiu:** Imuta-ike in Satsuma. (Pl. LIII, fig. 7)

Distr. Japan, Java, Sumatra, Ceylon, Europe, N. America, New Zealand.

Desmidium Swartzii AG. in RALFS Brit. Desm. 61, 1848; NÄGELI Gatt. einz. Alg. 131, 1849; De BARY Conj. 76, 1858; WOLLE Desm. U.S. 26, 1884; ROY & BISSET Journ. Bot. **24**, 242, 1886; WEST & CARTER Monogr. Brit. Desm. 5, 246, 1923; SMITH Wisc. Bull. **57**, 144, 1924; HOMFELD Pflanzenf. **12**, 88, 1929; KRIEGER Arch. Hydrobiol. suppl. **11**, 221, 1932; OKADA Journ. Imp. Fish. Inst. **30**, 195, 1934; FUJISAWA Journ. Jap. Bot. **10**, 444, 1934; TAYLOR Pap. Mich. Acad. Sci. **20**, 220, 1935; TAFT Ohio Journ. Sci. **45**, 204, 1945.

Filamentae spiraliter tortae; cellulae mediocres, circiter 2½ latiores plus quam longiores, modice constrictae, sinu angusto-lineari vel leviter aperto exterius late aperto; semicellulae late trapezoides, marginibus lateralibus oblique truncatis, marginibus lateralibus superioribus convergentibus, marginibus inferioribus leviter divergentibus, parte apicali semicellularum leviter elevatis et dilatatis, apicibus rectis cum processibus connexibus brevibus, inter cellulas proximas cum spatidis depressione apertis ornatis; membrana glabra. Long. 11–22 μ, Lat. 24–39 μ, Lat. isth. 21–28 μ.

Hab. **Hokkaido:** Yasuushi in Teshio; Kiritappu in Kushiro; Furutoi, Shimoyûbetsu, Nikuru-numa in Kitami; Shikaribetsu-wopputo in Tokachi; Minenobu, Horomui, Moseushi, Nakano near Sapporo in Ishikari; Yûfutsu, Tomakomai, Tôasa-numa, Numanohata in Iburi; Shizukari in Oshima. **Hondo:** Naga-numa of Mt. Hachimantai in Rikuchu; Aka-numa, Megata in Ugo; Hakuryu-ko, Chûkawa-ike, Ôishita, Hijiori-onuma in Uzen; Kobuchi-numa in Rikuzen; Bagyu-numa, Kashima-cho, Nanko, Hibushi-numa in Iwaki; Hôzawa-ike, Akai in Iwashiro; Ozegahara in Kôzuke; Inago of Kitamaki-mura, Kizaki, Okemi-ike, Kazafuki-kaminota in Shinano; Tanuki-numa in Suruga; Takashihara, Ônuma in Mikawa; Tamaru, Ishigaki-ike, Kanashôzu, Jôdo-ike in Ise; Mt. Hira, Fuse-ike, Oku-ike of Higashikusano-mura, Nukigawa in Oomi; Ko-ike, Ariga-ike, Mizoroga-ike in Yamashiro. **Shikoku:** Yamada in Tosa. **Kiushiu:** Kôga-muta of Aso in Higo; Ahira in Ôsumi; Imuta-ike in Satsuma. (Pl. LIII, fig. 5)

Distr. Japan, Kuriles, China, Siberia, Burma, India, Turkey, Europe, Greenland, N. & S. America, Australia, New Zealand, Africa.

Desmidium aptogonum BRÉB. in De BARY Conj. 76, 1858; WOLLE Desm. U.S. 27, 1884; ROY & BISSET Journ. Bot. **24**, 242, 1886; WEST Trans. Linn. Soc. Bot. **5**, 233, 1896; OKADA Journ. Imp. Fish. Inst. **30**, 194, 1934; YAMAGUCHI Rep. Limn. Kwant. Manch. 493, 1940.

Filamentae tortae, cellulae modicae, circiter 1½ latiores quam longiores, modice constrictae, sinu angusto-lineari ad verticem; semicellulae late oblongae, marginibus lateralibus late rotundis, apicibus in medio concavis autem leviter productis prope angulos, inter processos connexos apicis et cellulam proximam cum prominentia caviforme; a vertice visae triangulares, lateribus concavis, angulis bene rotundis. Long. 14.6–22.4 μ, Lat. 23–28 μ, Lat. isth. 16–22 μ.

Hab. **Hokkaido**: Okineppe in Nemuro; Kiritappu in Kushiro; Shimoyûbetsu, Nikuru-numa in Kitami; Toyokoro-konuma in Tokachi; Nakano near Sapporo, Horomui in Ishikari; Tôasa-numa, Yûfutsu in Iburi; Shizukari in Oshima. **Hondo**: Mt. Kanpû, Ogata, Aka-numa in Ugo; Hakuryu-ko, Chûkawa-ike, Ôishita in Uzen; Izu-numa in Rikuzen; Kôriyama, Hôzawa-ike, Akaiyachi in Iwashiro; Inago of Kitamaki-mura, Kizaki in Shinano; Biwa-ike in Owari; Ônuma in Mikawa; Ishigaki-ike, Jôdo-ike, Tamaru, Toba in Ise; Fuse-ike, Nukigawa in Oomi; Mizoroga-ike, Ariga-ike in Yamashiro; Ikejiri-ike in Tanba. **Shikoku**: Matsuyama in Iyo; Sumiyoshi-ike in Tosa. (Pl. LIII, fig. 3)

Distr. Japan, Manchuria, Siberia, China, Burma, India, Ceylon, Java, Europe, Australia, Madagascar, U.S.A., S. America.

Desmidium pseudostreptonema W. & G. S. WEST in GRÖNBLAD Act. Soc. Faun. Flor. Fenn. 47, 85, 1920; WEST & CARTER Monogr. Brit. Desm. 5, 244, 1923.

Filamentae tortae; cellulae modicae, leviter latiores quam longiores, modice constrictae, sinu acute aperto extremo angusto-lineari; semicellulae angusto et transverse oblongae, angulis lateralibus perfecte rotundis, apicibus rectis dimidiatis longioribus quam latioribus cellularum et cum processos connexos breves ornatis; a latere visae transverse rectangulares, lateribus leviter convexis; a vertice visae triangulares, lateribus leviter concavis, angulis rotundis. Long. 17–25 μ, Lat. 28–36 μ, Lat. isth. 17–19 μ.

Hab. **Hokkaido**: Kiritappu in Kushiro; Tomakomai in Iburi. **Hondo**: Inago of Kitamaki-mura in Shinano; Jôdo-ike, Tamaru in Ise.(Pl. LIII, fig. 2)

Distr. Ceylon, Australia, British Isles, Finland, Norway.

Desmidium Baileyi (RALFS) NORDST. in Lund. Univ. Arsskr. **16**, 4, 1880; ROY & BISSET Journ. Bot. **24**, 242, 1886; WEST Trans. Linn. Scc. Bot. **5**, 44, 1895; SMITH Wisc. Bull. **57**, 145, 1924; MESSIKOMMER Viertelj. Naturf. Ges. Zurich **72**, 349, 1927; OKADA Journ. Imp. Fish. Inst. **30**, 194, 1934.

Cellulae modicae, quadrangulares, leviter latiores quam longiores, non constrictae vel medio paullo depressae; semicellulae transverse quadrangulares, marginibus lateralibus parallelis, apicibus conspicue excavatis, processibus connexis brevibus, inter cellulas proximis et processis apicalibus elliptico-concaviformibus; a vertice visae triangulares. Long. 12.6–19.6 μ, Lat. 14–24 μ.

Hab. **Hokkaido**: Shimoyûbetsu, Nikuru-numa in Kitami; Toyokoro in Tokachi; Nakano near Sapporo, Horomui in Ishikari; Tomakomai, Yûfutsu in Iburi; Shizukari in Oshima. **Hondo**: Moritake-ôtsutsumi, Megata in Ugo; Chûkawa-ike in Uzen; Izu-numa, Kesho-numa in Rikuzen; Bagyu-numa in Iwaki; Akai in Iwashiro; Kotsutsumi-nishi-ike in Mikawa; Biwa-ike in Owari;

Ishigaki-ike, Tamaru in Ise; Shinohara-ike, Fuse-ike, Nukigawa in Oomi; Mizoroga-ike in Yamashiro. **Kiushiu:** Ahira in Ôsumi. (Pl. LIII, fig. 4)

Distr. Japan, Ceylon, Europe, N. America, Africa.

Gen. **Sphaerozosma** CORDA

in HASSALL Brit. Freshw. Alg. 348, 1845; RALFS Brit. Desm. 65, 1848; De BARY Conj. 76, 1858; RABENHORST Flor. Europ. Alg. 148, 1868; WEST & CARTER Monogr. Brit. Desm. **5**, 206, 1923; SMITH Wisc. Bull. **57**, 136, 1924; WEST & FRITSCH Treat. Brit. Alg. 284, 1927; PRINTZ ENGLER'S Pflanzenf. **3**, 360, 1927; SMITH Freshw. Alg. U.S. 586, 1933.

Cellulae generaliter parvae, compressae, profunde constrictae ad medium, sinu aperto, angusto vel lineari; semicellulae ellipticae, oblongae vel subrectangulares, marginibus lateralibus glabris vel granulatis, apicibus tuberculis parvis 1–2 vel processibus capitatibus brevibus praeditis, capitalibus processibus ad efformandos longo filamentos conjunctis; chromatophoris axialibus singulis et cum pyrenoidibus singulis in unaquaque semicellulae; membrana glabra, punctata vel cum seriebus transversis granulorum ordinatis; cellulae in filamentos longos formantes; zygosporae globosae, rectangulares vel oblongae, glabrae vel spinis subulatis ordinatae.

1a. Cellulae minutae, 7–14 μ in latitudinem; isthmo rotundo vel excavato.
  2a. Sinu late excavato sine granulis marginibus .... **Sph. excavatum**
  2b. Sinu obtuso vel subacuto, cum granulis marginibus .... **Sph. granulata**
    3a. Semicellulae cum granulis duobus marginibus et granulis 3–4 intra marginem .... f. **typica**
    3b. Semicellulae cum granulis tribus ambitu marginis .... var. **trigranulatum**
1b. Cellulae modicae, 18–27 μ in latitudinem, sinu acuto aperto.
  2a. Semicellulae oblongo-ellipticae, cum granulis duobus ad ambitum lateris marginis utrobique .... **Sph. aubertianum**
    3a. Membrana glabra, sine serie horizontali granulorum .... f. **typica**
    3b. Membrana cum serie horizontali granulorum .... var. **Archeri**
  2b. Semicellulae subreniformes, sine granulis marginibus, sinu aliquando angusto-lineari .... **Sph. vertebratum**
    3a. Cellulae tam longae quam latae .... f. **typica**
    3b. Cellulae $1\frac{1}{2}$-plo latiores quam longiores, sinu profundiore .... var. **latius**

Sphaerozosma excavatum RALFS in BRIT. Desm. 67, 1848; WOLLE Desm. U.S. 29, 1884; ROY & BISSET Journ. Bot. **24**, 242, 1886; WEST Trans. Linn. Soc. Bot. **5**, 231, 1896; MIGULA Krypt. Fl. **2**, 563, 1907; WEST & CARTER Monogr. Brit. Desm. **5**, 211, 1923; ALLORGE Rev. Alg. **5**, 367, 1930; OKADA ASAHINA'S Inkwa. 189, 1939; PRESCOTT & SCOTT Trans. Amer. Micr. Soc. **61**, 25, 1942.

Filamentae non tortae sed facile separatae; cellulae parvae, circiter tam longae quam latae, profunde constrictae, sinu late aperto excavato ad verticem rotundato, isthmo leviter elongato; semicellulae transverse subhexagonales, apicibus leviter concavis processibus binis apicalibus connexibus minutis ornatis; a latere visae ellipticae; membrana glabra. Long. 8.4–11 μ, Lat. 7–10.8 μ, Lat. isth. 4–6 μ.

Hab. **Hondo**: Mt. Hakkoda in Mutsu; Koke-numa, Nishi-numa in Ugo; Hijiori-onuma, Mt. Gassan, Ôishitano-junsai-tsutsumi in Uzen; Hizume in Rikuchu; Ishigaki-ike in Ise; Mt. Hira in Oomi; Mizoroga-ike, Koike, Sawano-ike in Yamashiro. (Pl. LIII, fig. 22)

Distr. Japan, Manchuria, India, Java, Europe, Spitzbergen, Nova Zembla, Greenland, N. America, Brazil, Australia, Africa.

Sphaerozosma granulatus ROY & BISSET in Journ. Bot. **24**, 242, 1886; BERNARD Dep. agr. Indes. Néerl. 20, 1909; SCHULZ Bot. Arch. **2**, 144, 1922; l.c. **3**, 255, 1923; Dick l.c. **3**, 229, 1923; WEST & CARTER Monogr. Brit. Desm. **5**, 213, 1923; KRIEGER Arch. Hydrobiol. suppl. **11**, 220, 1932; SKUJA Act. Horti Bot. Univ. Latv. **7**, 84, 1934; OKADA Journ. Imp. Fish. Inst. **30**, 191, 1934.

Cellulae parvae, circiter tam longae quam latae vel leviter latiores, profunde constrictae, sinu aperto semicirculari; semicellulae subelliptico-hexagonales, angulis lateralibus truncato-rotundatis granulis binis minutis verticaliter ornatis, apice recto cum processibus connexis apicalibus in latere separate ornatis; membrana glabra cum granulis minutis intra marginem ordinatis; a latere visae circulares, lateribus cum granulis minutis lateralem ordinatis. Long. 7.8–8.4 μ, Lat. 8.4–9.7 μ, Lat. isth. 3–5.6 μ.

Hab. **Hokkaido**: Onne-numa in Nemuro; Akan-junsai-numa, Kiritappu in Kushiro; Nikuru-numa, Notoro-ponto, Komukai-ponto, Shimoyûbetsu, Sarufutsu in Kitami; Toyokoro-konuma in Tokachi; Kamikoshi-ukishimahara, Numano-taira on Mt. Daisetsu, Minenobu, Moseushi in Ishikari; Tomakomai, Yûfutsu, Tôasa-numa in Iburi; Shizukari, Junsai-akanuma, Ko-numa in Oshima. **Hondo**: Mt. Hakkoda, Mt. Hachimantai in Mutsu; Koke-numa, Moritake-ôtsutsumi, Megata, Mt. Kurikoma, Mt. Komagatake in Ugo; Hakuryu-ko, Mt. Gassan, Ôishita, Chûkawa-ike, Mt. Sugigamine of Zawo in Uzen; Izu-numa, Naga-numa, Kesho-numa, Kirifushi-numa in Rikuzen; Nogiwano-kwannon-ike, Hôzawa ike, Kôriyama, Mt. Azuma, Numano-taira on Mt. Bandai in Iwashiro; Oze in Kôzuke; Gôno-ike, Kitaura in Hitachi; Higusa-numa in Shimofusa; Mohara in Kamifusa; Senjôgahara in Shimotsuke; Takayachi on Mt. Myoko in Echigo; Sennin-ike, Mt. Tateyama, Tarobei-daira, Kurobegoro-daira in Etchû; Kamikôchi, Happo-ridge, Ashinota-ike, Mt. Kirigamine, Inago of Kitamaki-mura, Midoriga-ike on Mt. Yatsugatake in Shinano; Takashihara, Ônuma in Mikawa; Biwa-ike in Owari; Jôdo-ike, Tamaru, Toba in Ise; Nukigawa, Lake Biwa, Shinohara-ike, Fuse-ike in Oomi; Ko-ike in Yamashiro; Ikejiri-ike in Tanba. **Shikoku**: Shiramizu-pass near Matsuyama in Iyo; **Kiushiu:** Yabakei in Bunzen; Lake Ikeda in Satsuma. (Pl. LIII, fig. 23)

Distr. Japan, Kuriles, Manchuria, China, Java, Ceylon, Europe, N. & S. America, Australia, New Zealand, Africa.

var. **trigranulatum** W. & G. S. WEST in Trans. Roy Irish Acad. **5**, 59, 1902; WEST & CARTER Monogr. Brit. Desm. **5**, 214, 1923.

Var. sinu sublineari aperto; marginibus lateralibus granulis tribus minutis ornatis (non intra marginem lateralem). Long. 10.6 μ, Lat. 10.6 μ, Lat. isth. 3 μ.

Hab. **Hondo:** Izu-numa in Rikuzen; Akaiyachi in Iwashiro; Rokujizo in Yamashiro. (New to Asia) (Pl. LIII, fig. 8)

Distr. Ireland.

Sphaerozosma aubertianum WEST in Journ. Bot. **27**, 206, 1889; Trans. Linn. Soc. Bot. **5**, 230, 1896; Trans. Roy. Soc. Edinb. **41**, 505, 1905; WEST & CARTER Monogr. Brit. Desm. **5**, 207, 1923; TAYLOR Pap. Mich. Acad. Sci. **20**, 217, 1935.

Filamentae tortae; cellulae parvae, leviter latiores quam longiores, profunde constrictae, sinu acute aperto; semicellulae angusto-ellipticae vel elliptico-oblongae, angulis lateralibus granulis binis minutis in vertice ornatis, apice vix inflato cum processibus connexis duobus; a latere visae subcirculares, apicibus cum processis connexis duobus ornatis; a vertice visae oblongo-ellipticae. Long. 14 μ, Lat. 19 μ, Lat. isth. 7 μ.

Hab. **Hondo:** Moritake-ôtsutsumi in Ugo; Naga-numa, Izu-numa in Rikuzen; Inago of Kitamaki-mura in Shinano; Nukigawa in Oomi. (New to Asia) (Pl. LIII, fig. 6)

Distr. Europe, N. America, Australia.

var. **Archeri** (GUTW.) W. & G. S. WEST in Trans. Roy. Soc. Edinb. **12**, 505, 1905; WEST & CARTER Monogr. Brit. Desm. **5**, 208, 1923; SMITH Wisc. Bull. **57**, 189, 1924; DICK Mitt. Pfälz Ver. Nat. Pollichia **3**, 141, 1930; OKADA Journ. Imp. Fish. Inst. **30**, 191, 1934; ASAHINA's Inkwa. 189, 1939.

Var. processibus apicalibus connexibus elongatis et propinquis ornatis, cum seriebus duobus granulorum in transversis trans unamquamque semicellulas. Long. 15.4–17 μ, Lat. 19.6–21 μ, Lat. isth. 5–6 μ.

Hab. **Hokkaido:** Shimoyûbetsu in Kitami. **Hondo:** Ozegahara in Kôzuke; Takashihara in Mikawa; Oku-ike of Higashikusano-mura in Oomi. (Pl .LIII, fig. 20)

Distr. Japan, Kuriles, Siberia, India, Europe, U.S.A., Australia.

Sphaerozosma vertebratum (BRÉB.) RALFS in GRÖNBLAD Act. Soc. Faun. Flor. Fenn. **49**, 63, 1921; WEST & CARTER Monogr. Brit. Desm. **5**, 209, 1923; KRIEGER Arch. Hydrobiol. suppl. **11**, 220, 1932.

Filamentae tortae; cellulae parvae, circiter tam longae quam latae, profunde constrictae, sinu acute aperto; semicellulae oblongae vel subreniformes, apicibus paene rectis, lateralibus rotundatis; a vertice visae oblongae; a latere visae ovatae cum processibus apicalibus duobus ad apicem; membrana glabra. Long. 15.4–19.6 μ, Lat. 17–20 μ, Lat. isth. 5 μ.

Hab. **Hokkaido**: Okineppe in Nemuro; Shimoyûbetsu in Kitami; Toyokorokonuma in Tokachi. **Hondo**: Lake Biwa in Oomi. (New to Japan) (Pl. LIII, fig. 24)

Distr. India, Java, Europe, Faeroes, U.S.A., Patagonia.

var. **latius** W. & G. S. WEST in WEST & CARTER Monogr. Brit. Desm. **5**, 211, 1923; OKADA Bot. Mag. **50**, 258, 1936.

Cellulae compressiores, circiter $1\frac{1}{2}$ latiores quam longiores, semicellulae late oblongae vel oblongo-ellipticae non reniformes, sinu profundiore, apice convexo. Long. 12.6–15.4 μ, Lat. 19.5–21 μ, Lat. isth. 5.6–7 μ.

Hab. **Hokkaido**: Tomakomai in Iburi. **Hondo**: Ôishita in Uzen; Ô-numa in Mikawa; Mizoroga-ike in Yamashiro; Ikejiri-ike in Tanba. (Pl. LIV, fig. 1)

Distr. Japan, British Isles.

Gen. **Onychonema** WALL.

in WEST & CARTER Monogr. Brit. Desm. **5**, 215, 1923; SMITH Wisc. Bull. **57**, 135, 1924; WEST & FRITSCH Treat. Brit. Alg. 284, 1927; PRINTZ ENGLER's Pflanzenf. **3**, 360, 1927; SMITH Freshw. Alg. U.S. 585, 1933.

Cellulae in filamentos longos conjunctae in processibus apicalibus duobus; cellulae parvae, compressae, profunde constrictae, sinu angusto; semicellulae ellipticae vel reniformes, angulis lateralibus glabris vel spinis longis singulis praeditis, apicibus cum processibus apicalibus duobus in lateribus oppositis apici praeditis; membrana glabra vel seriebus transversis granulorum vel punctorum praedita; chromatophoris axialibus singulis et pyrenoidibus singulis in unaquaque semicellula.

1a. Semicellulae cum marginibus lateralibus rotundis et sine spinis .... **O. filiformis**
1b. Semicellulae cum angulis lateralibus acutis et spinis convergentibus ordinatae .... **O. laeve**

Onychonema filiformis (EHRENB.) ROY & BISSET in Journ. Bot. **24**, 242, 1886; NORDSTEDT K. Sv. Vet. Akad. Handl. **22**, 29, 1888; MIGULA Krypt. Fl. **2**, 562, 1907; WEST & CARTER Monogr. Brit. Desm. **5**, 216, 1923; SMITH Wisc. Bull. **57**, 135, 1924; ALLORGE Rev. Alg. **5**, 368, 1930; PRESCOTT & SCOTT Trans. Amer. Micr. Soc. **61**, 25, 1942.—*Sphaerozosma filiformis* RALFS in Brit. Desm. 209, 1848.

Filamentae tortae; cellulae parvae, circiter longiores quam latae vel leviter latiores, profunde constrictae, sinu angusto-lineari exterius leviter aperto; semicellulae ellipticae vel subreniformes, dorso convexiore quam ventre, angulis lateralibus late rotundis sine spinis, processibus binis apicalibus aeque longis divergentibus oblique projectis; a latere visae subcirculares; membrana glabra et cum serie duabus punctorum horizontalium trans unumquamque semicellulam. Long. 11–12.6 μ, Lat. 11–14 μ, Lat. isth. 3–5.6 μ.

Hab. **Hokkaido:** Kiritappu in Kushiro; Yûfutsu, Tomakomai, Tôasa-numa in Iburi. **Hondo:** Kôriyama in Iwashiro; Oze-numa in Kôzuke; Inago of Kitamaki-mura in Shinano; Fuse-ike in Oomi. **Kiushiu:** Ahira in Ôsumi. (Pl. LIV, fig. 9)

Distr. Japan, Siberia, India, Celebes, Europe, U.S.A., Australia, New Zealand, Tasmania.

Onychonema laeve NORDST. in WEST Ann. Roy. Bot. Gard. Calcatta **6**, 224, 1907; WEST & CARTER Monogr. Brit. Desm. **5**, 218, 1923; SMITH Wisc. Bull. **57**, 136, 1924; KRIEGER Arch. Hydrobiol. suppl. **11**, 220, 1932; OKADA ASAHINA's Inkwa. 189, 1939.

Cellulae mediocres, leviter latiores quam longiores, profunde constrictae, sinu angusto-lineari ad verticem exterius aperto; semicellulae oblongae vel late hexagono-reniformes, angulis lateralibus leviter rotundis spinis brevibus rabustis deorsum directis ornatis, apicibus rectis cum processibus connexis crassis 2 oblique dispositis ornatis; a latere visae circulares; a vertice visae ellipticae, polis cum spinis brevibus singulis. Long. 15–22 μ, Lat. 17–25 μ, Lat. isth. 7–8.6 μ.

Hab. **Hokkaido:** Horomui in Ishikari; Tomakomai in Iburi. **Hondo:** Ô-numa in Mikawa; Lake Biwa, Matsubara-naiko in Oomi; Tamaru in Ise. (Pl. LIV, fig. 8)

Distr. Siberia, Java, Sumatra, Burma, India, Ceylon, Europe, U.S.A., Brazil, Australia.

General character of Inland waters and their general feature of Desmid-flora

Inland waters are the direct and extensive habitat for the growth of algae, and since Desmids are found chiefly in quiet waters, it is above all necessary to explain the general nature of inland waters. Studies of the physico-chemical nature of the inland waters of Japan, especially that of the larger lakes and swamps, have been made by Dr. S. YOSHIMURA after extensive research. Desmids usually grow in small ponds and swamps, as do benthos and epiphyte, and the members of pelagic life are few among them. Therefore, the findings that have been ascertained as regards lakes, cannot be suitably applied to the case of small ponds and swamps, but they are very helpful in giving knowledge of the general state of inland waters. It is difficult to study inland waters in their natural condition nowaday, since the land has been so extensively utilized ; this is especially true around lowland waters. The writer has made the following divisions to facilitate the present study:

1. Lakes: As mentioned above, representative lakes of Japan were analysed by Dr. S. YOSHIMURA and others. These results are shown in table 1.

Table 1. The composition of dissolved substances in lakes of Japan

Name	Date of sampling	pH	SiO_2	SO_4	Cl	Ca	Fe	N	P_2O_5	$KMnO_4$ cons.	Number of species
Akan-ko	1931 24/VII	>7.6	27.0	60	20.5	12.5	0.02	0.13	0.01	7.0	6
Toro-ko	.. 27/VII	8.8	29.0	2	6.0	7.2		0.76	0.08	23.0	0
Shikotsu-ko	.. 29/VII	7.5	22.2	42	25.5	15.4		0.05	0.01	5.0	0
Tôya-ko	.. 31/VII	7.2	13.6	—	18.5	10.7		0.07	0.00	9.5	0
Hangetsu-ko	.. 22/VII	8.8	22.2	0	7.5	15.4		0.35	0.05	13.5	2
Numazawa-numa	.. 12/VII	6.5	10.3	12	5.0	4.3		0.01	0.01	11.5	0
Chûzenji-ko	.. 26/X	7.2	21.2	14	3.5	7.5	0.00	0.08	0.02	4.6	3
Yuno-ko	.. 23/X	7.0	26.6	19	4.0	11.7		0.11	0.02	2.2	1
Kitaura	.. 9/VIII	8.5	16.1	24	29.0	7.9		0.24	0.10	9.5	3
Ashino-ko	1930 27/IX	6.8	10.6	—	0.0	2.0	0.00	0.13	—	7.5	4
Yamanaka-ko	1931 19/VIII	8.1	10.2	0	0.0	7.9		0.15	0.04	11.5	2
Kawaguchi-ko	.. 18/VIII	8.1	6.6	3	3.5	8.6		0.23	0.02	14.0	5
Shôji-ko	1930 7/X	7.4	9.4	1	3.0	6.1		0.12	—	11.0	2
Motosu-ko	.. 8/X	7.0	4.9	1	0.0	5.4		0.04	—	7.0	2
Nojiri-ko	1916 22/VII	7.3	4.0	1.8	11.6	6.9	0.03	—	—	10.2	5
Kizaki-ko	1930 23/X	6.7	13.6	2	0.0	6.4	0.0	0.16	—	4.0	6
Nakatsuna-ko	.. 21/X	6.5	11.2	3	0.0	6.4		0.13	—	4.5	1
Awoki-ko	.. 22/X	6.8	9.6	3.5	0.0	6.1	0.00	0.12	0.01	4.0	2
Suwa-ko	1931 20/VIII	8.4	14.4	14.5	6.0	10.7		0.27	0.04	10.0	2
Matsubara-ko	1928 I	6.4	38.4	37.0	4.0	15.1	0.05	—	0.02	5.8	7
Biwa-ko	1930 24/VIII	7.2	2.4	—	7.0	8.6		0.16	—	6.5	60
Ikeda-ko	1929 4/VIII	7.3	13.4	—	7.0	3.8		—	0.03	—	8
Unagi-ike	.. 3/VIII	7.5	21.5	—	6.0	4.8		—	0.00	—	9

The pH values range from 6.5 to 8.5 and are rarely higher than 8.8 in plankton-rich waters. The consumption of $KMnO_4$ is very small, comprising less than 10 mg per litre, except in Lake Tôro-ko, which is fairly large, due to water flowing in from the surrounding moorlands. The total amount of nitrogen is less than 0.1 mg per litre in oligotrophic lakes, but more than 0.2 mg per litre in eutrophic lakes. The amount of phosphate as shown in P_2O_5 is less than 0.01 mg per litre in oligotrophic lakes, but more than 0.01 mg per litre in eutrophic lakes. The silica content is generally more than 10 mg per litre in most lakes, but rarely below 10 mg per litre. Chloride is found in varying quantities: the amounts in lakes Shikotsu, Tôya, Akan, and Kitaura being fairly large; whereas in others it is below 10 mg per litre. The first three lakes are probably affected by hot-springs located near their shores, and the last named lake consist of relics of brackish water in the pass. The iron content was found to be very small in all the lakes examined. The calcium content is somewhat large in some of the lakes affected by the hot-springs. Sulphate is found in various quantities. True planktonic Desmids were usually found to be rather scanty in general, except in a few lakes, but they are entirely missing in the caldera lakes of northern Hondo and Hokkaido. There are some remarkable species of Desmids in central Hondo and in the volcanic lakes of southern Kiushiu. The writer has investigated these lakes and the results of examination are shown in table 2.

Table 2. The plankton Desmids in lake waters of Japan

Name of species	Habitats	Name of species	Habitats
Gonatozygon Brébissonii	Shôji	*Cl. toxon*	Matsubara
G. monotaenium	Motosu, Chûzenji, Kizaki, Biwa, Matsubara	*Cl. setaceum*	Unagi
		Cl. venus var. *incurvum*	Ikeda
		Cl. navicula	Kizaki
G. aculeatum var. *gracile*	Ikeda, Unagi	*Pleurotaenium Trabecula*	Ashinoko, Nojiri, Biwa
Closterium aciculare	Akan, Biwa	*Pl. Ehrenbergii*	Kawaguchi, Biwa
Cl. gracile	Biwa	*Cosmarium minimum*	Suwa
Cl. acerosum	Akan, Biwa	*C. Hammeri* var. *protuberans*	Nojiri, Biwa
Cl. praelongum	Biwa		
Cl. parvulum	Biwa	*C. quadrifarium* f. *hexasticha*	Matsubara
Cl. Leibleinii	Biwa		
Cl. dianae	Biwa	*C. sexangulare*	Kawaguchi
Cl. moniliferum	Biwa, Akan	*C. contractum* var. *ellipsoideum*	Ikeda, Biwa
Cl. Ehrenbergii	Biwa	*C. exiguum*	Ikeda
Cl. acutum	Kitaura	*C. succisum*	Ikeda, Unagi
Cl. Kützingii	Nojiri	*C. depressum*	Biwa

Table 2. The plankton Desmids in lake waters of Japan (continued)

Name of species	Habitats
C. circulare	Biwa
C. angulosum	Biwa
C. margaritatum	Biwa
C. Quadrum	Biwa
C. reniforme	Biwa
C. punctulatum	Biwa
C. .. var. *subpunctulatum*	Biwa
C. obtusatum	Biwa
C. galeritum var. *minus*	Biwa
C. pachydermum var. *aethiopicum*	Biwa
C. Lundellii var. *ellipticum*	Biwa
C. pseudoprotuberans	Biwa
C. malinvernianum	Biwa
Arthrodesmus convergens f. *curta*	Biwa
A. triangularis	Kizaki, Chûzenji
Xanthidium hastiferum var. *curvispinosum*	Biwa
Staurastrum paradoxum	Kitaura, Kizaki, Matsubara, Suwa, Aoki, Nojiri, Yunoko, Biwa, Chûzenji, Yamanaka
St. .. var. *parvum*	Hangetsu-ko, Shôji
St. .. var. *longipes*	Kitaura
St. dejectum	Kawaguchi
St. apiculatum	Ashino-ko
St. asterias var. *divergens*	Kawaguchi
St. coarctatum var. *subcurtum*	Unagi
St. laeve	Hangetsu-ko, Unagi
St. asteroideum var. *nanum*	Unagi, Awoki
St. limneticum var. *Burmense*	Ikeda, Unagi
St. tetracerum	Ikeda, Matsubara
St. biexcavatum	Unagi
St. sexangulare var. *subglabrum*	Unagi
St. cingulum var. *inflatum*	Ashino-ko
St. Sonthalianum	Biwa
St. Sebaldi var. *ornatum*	Biwa
St. .. var. *productum*	Biwa
St. Biwaensis	Biwa
St. dorsidentiferum var. *ornatum*	Biwa, Akan
St. leptodermum f. *minor*	Biwa
St. .. var. *capitatum*	Biwa
St. pingue	Biwa
St. longiradiatum	Akan, Biwa
St. leptocladum	Biwa
St. arctiscon	Biwa
St. Hantzii var. *japonicum*	Biwa
St. gracile	Akan, Biwa
St. subbörgesenii	Biwa
Micrasterias crux-melitensis	Biwa
M. .. var. *superflua*	Biwa
M. mahabuleshwarensis	Biwa
M. .. var. *Wallichii*	Biwa
M. denticulata var. *notata*	Biwa
Cosmocladium saxonicum	Biwa
C. constrictum	Biwa
Spondylosium ellipticum	Biwa
Sp. Lütkemülleri	Biwa
Sp. moniliforme	Biwa
Hyalotheca mucosa	Kawaguchi, Kizaki, Biwa
H. dissiliens	Nojiri
Desmidium aptogonum	Motosu, Kizaki, Nakatsuna, Matsubara
D. coarctatum	Matsubara
Sphaerozosma granulatus	Ikeda, Ashino-ko, Biwa
S. vertebratum	Biwa
Onychonema laeve	Biwa
Gymnozyga moniliformis	Suwa

2. Swamps: the swamps are small, shallow ponds which retain their relatively natural state, and their littoral margins are furnished with aquatic plant life. The typical communities consist of *Phragmites* zone, emergent, floating leaves and submerged plants, and also among them some *Utricularia* species were found floating. The waters are destrophicated to various degrees; in northern Japan the majority of the swamps are of a perfect destrophic type, as is also the case in mountainous regions. The state of the water of all the places observed was found to be almost constant, and the state of the swamps was found stable, and no remarkable changes were observed. These vegetational and undisturbed conditions seem suitable for the growth of Desmids and indicate such a result after many years under successive climates.

The pH value range from 4.9 to 6.8. The analytical results of the swamps and ponds studied by the writer are shown in table 3.

The nitrogenous compounds were analysed in the state of free ammonia and nitrate. The majority of the swamps and ponds show 0.01-0.05 mg per litre of NH_4-N, and the nitrate found in them was of extremely small amount, although fairly rich, reaching 0.1 mg or more per litre in the swamps surrounded by rice fields. Quantities of soluble phosphate were also found to be very limited, being below 0.001 mg per litre. The silica content of these swamps and ponds is usually below 10 mg per litre in areas surrounded by low moors, but more than 10 mg per litre in areas with inflowing water. The consumption of $KMnO_4$ is usually large, being more than 20 mg per litre, and exhibit a high amount of accumulation of humus, so that most of them are destrophicated to various degrees. The amount of chloride is more than 20 mg per litre in the swamps near the coastal regions, but below 10 mg per litre in swamps supplied by moor waters or surrounded by moor-

The water analyses were made in the following manner: pH was determined by CLARKE's colorimetric method, chloride by MOHR's method in titrating by the normal solution of silver nitrate in the presence of potassium chromate, and consumption of $KMnO_4$ by oxidising substance was determined by the ordinary method. Free ammonia was estimated colorimetrically by adding NESSLER's reagents, and nitrate by diphenylamine-sulphuric-acid method of TILLMANS & SUTTHOF. Free phosphate was estimated by DENIGÈS method, and silica by the colorimetric method of DIÉNERT & WANDENBULCKE. Calcium was precipitated as calcium oxalate, by adding ammonium oxalate to the sample in the presence of ammonium. Then on the addition of sulphuric acid, calcium oxalate was converted into oxalic acid, which was then titrated by a normal solution of potassium permanganate. Iron was determined by the colorimetric method, all iron compounds being oxidised to ferric form, and potassium thiosulphate added. Sulphate was determined colorimetrically by the balium chromate method: to the sample balium chloride was first added, and afterwards potassium chromate. The amount of chromate ion in the sample was estimated colorimetrically by the standard solution of potassium chromate.

Table 3. The water-analysis of the swamp-waters of Japan (mg per litre)

Name of swamp	Date of sampling	Hour	Air temperature	Water temperature	pH	Consumption of $KMnO_4$	NH_4-N	NO_3-N	PO_4-P	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Onne-numa	1957 20/VII	13.00	17.0	19.5	4.9	36.2	0.05	0.00	0.001	1.92	15.87	0.08	2.6	0.8	43
Tanne-to	.. 20/VII	11.00	17.0	19.5	5.1	51.4	0.9	0.00	0.001	0.64	15.37	0.07	6.0	2.5	—
Chôbushi-numa	.. 21/VII	11.00	20.0	21.5	6.9	50.0	0.01	0.00	0.000	1.07	20.14	0.005	1.6	2.5	15
Tokotan-ko	.. 22/VII	8.20	21.0	21.6	5.0	44.1	0.06	0.00	0.001	1.71	14.35	0.02	5.2	6.5	32
Toyokoro-numa	1956 21/VII	12.30	24.0	23.5	5.1	28.7	0.04	0.00	0.001	13.91	3.8	0.04	4.4	4.9	68
Toyokoro-konuma	.. 21/VII	14.00	26.5	23.0	5.0	48.8	0.09	0.00	0.001	3.85	10.5	0.03	4.8	4.5	74
Kimoma-numa	1957 30/VII	9.00	23.5	22.0	5.0	54.6	0.14	0.00	0.001	0.64	11.82	0.005	3.2	2.5	—
Tonbetsu-ponto	.. 29/VII	17.00	24.3	23.7	4.9	41.5	0.03	0.00	0.001	5.14	12.5	0.02	1.2	4.5	10
Kabuto-numa	.. 30/VII	17.20	24.0	22.5	5.0	50.0	0.03	0.00	0.003	16.05	17.22	0.35	3.6	4.5	—
Tôro-ko	.. 23/VII	11.00	27.5	25.0	5.1	34.2	1.0	0.45	0.001	18.83	5.57	0.01	7.2	5.5	6
Shirarutoro-numa	.. 23/VII	7.30	20.5	21.0	5.1	49.5	1.7	0.00	0.001	18.83	3.08	0.005	0.8	5.5	2
Harutori-ko	.. 23/VII	14.00	24.0	26.0	7.8	67.2	0.05	0.52	0.003	4.49	4205.0	0.02	128.2	80.0	0
Swamp of Tomakomai	1956 11/VII	9.00	17.0	19.0	6.9	30.8	0.005	0.00	0.002	17.12	8.8	0.005	7.2	83.3	51
Shiraoi-poroto-numa	1957 31/VII	10.45	23.4	23.0	5.1	32.0	0.06	0.00	0.001	20.33	6.92	0.65	0.8	100.0	29
Horomui	1956 24/VII	11.00	27.5	23.0	4.9	44.7	0.02	0.02	0.03	4.28	17.3	0.15	13.2	6.3	9
Ara-numa	1958 22/VII	13.00	21.7	22.5	5.5	15.17	0.04	0.00	0.000	6.63	28.54	0.008	4.0	5.5	20
Sakyo-numa	.. 22/VII	14.35	21.0	22.5	5.5	27.18	0.008	0.00	0.005	7.06	26.85	0.04	6.4	3.8	13
Shimokita-ônuma	.. 23/VII	10.30	21.5	22.6	6.8	24.28	0.005	0.00	0.005	6.63	27.69	0.03	2.8	2.5	1
Shimokita-naga-numa	.. 23/VII	11.00	20.8	20.0	6.5	12.64	0.01	0.00	0.000	7.92	23.47	0.005	4.8	5.8	7
Shimokita-ane-numa	.. 23/VII	14.45	21.5	21.0	6.5	18.33	0.03	0.00	0.000	6.42	25.16	0.15	2.4	6.5	3
Bense-numa	.. 26/VII	12.00	27.5	32.7	4.9	34.20	0.02	0.00	0.001	0.43	—	0.01	1.8	3.3	29
Hirataki-numa	.. 26/VII	9.00	24.3	25.7	6.6	26.54	0.005	0.00	0.001	5.14	52.01	0.03	3.6	6.2	0
Ôtaki-numa	.. 26/VII	11.00	26.0	31.0	5.3	39.18	0.04	0.00	0.001	1.71	54.74	0.03	3.2	6.2	0
Kyutaino-ike	.. 26/VII	14.30	27.0	31.0	5.4	32.86	0.03	0.00	0.001	4.07	48.97	0.08	2.8	5.5	25
Kotsutsumi	.. 26/VII	16.00	27.2	31.0	5.3	61.95	0.55	0.01	0.001	3.64	48.63	0.1	1.44	6.0	42
Karaso-numa	.. 30/VII	9.15	25.4	25.2	6.9	32.23	0.06	0.00	0.001	7.06	28.54	0.02	3.8	12.5	7
Ogata	.. 30/VII	11.50	28.0	26.8	5.4	30.08	0.01	0.00	0.001	7.06	11.82	0.04	2.4	1.0	70
Hakkoda-naganuma	.. 28/VII	14.00	18.8	19.5	5.6	27.88	0.001	0.00	0.000	10.70	3.10	0.008	9.6	17.5	—

Table 3. The water-analysis of the swamp-waters of Japan (Continued)

Name of swamp	Date of sampling	Hour	Air temperature	Water temperature	pH	Consumption of $KMnO_4$	NH_4-N	NO_3-N	PO_4-P	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Hyotan-numa of Hakkoda	1958 28/VII	14.40	18.8	16.5	5.6	29.74	0.001	0.00	0.000	20.33	3.79	0.04	7.2	6.8	—
Naganuma of Hachimantai	.. 19/VII	14.20	21.2	22.0	5.6	34.13	0.04	0.00	0.000	6.42	3.71	0.03	1.6	3.0	43
Ketakura-numa	.. 31/VII	11.45	26.5	24.8	5.6	20.54	0.03	0.00	0.000	7.49	4.10	0.01	1.52	4.5	—
Hoso-numa	.. 31/VII	15.30	27.0	27.0	5.5	20.86	0.02	0.00	0.000	9.42	5.57	0.02	1.2	1.5	20
Ôishitano-junsai-tsutsumi	.. 1/VIII	13.00	28.5	30.0	5.1	35.39	0.01	0.00	0.001	6.85	12.83	0.07	0.8	2.8	84
Hakuryu-ko	.. 2/VIII	11.00	28.4	29.4	5.4	28.76	0.03	0.45	0.000	7.49	23.46	0.005	8.41	11.5	98
Byodô-numa	1959 14/VII	11.50	24.5	26.8	6.5	24.44	0.02	0.00	0.000	12.84	3.85	0.005	4.01	21.5	17
Kirifushi-numa	.. 14/VII	14.40	23.6	26.5	6.6	29.81	0.05	0.00	0.000	3.21	3.38	0.003	2.00	20.5	14
Kesho-numa	.. 15/VII	10.00	24.0	25.4	6.7	22.06	0.04	0.00	0.000	3.85	3.04	0.001	1.6	17.5	67
Kobuchi-numa	.. 15/VII	15.10	29.2	27.8	6.9	29.22	0.03	0.01	0.000	8.13	5.40	0.005	5.21	22.5	35
Izu-numa	.. 15/VII	16.10	27.5	27.0	6.8	35.77	0.07	0.01	0.000	11.77	4.39	0.005	8.01	23.5	62
Naga-numa	.. 3/IX	14.50	29.8	31.6	6.6	28.62	0.03	0.01	0.000	18.19	13.68	0.09	2.60	13.5	42
Oze-numa	1958 4/IX	10.30	20.7	20.2	6.6	20.45	0.005	0.00	0.000	8.35	1.86	0.003	3.13	8.5	67
Ômine-numa	.. 5/IX	12.00	27.2	25.3	5.4	26.52	0.02	0.00	0.000	8.13	1.86	0.08	0.96	1.5	53
Kôridono-ike	.. 6/IX	15.20	31.0	28.5	5.3	26.02	0.02	0.00	0.000	7.92	5.23	0.09	0.8	3.5	38
Uno-ike	.. 7/IX	9.40	26.5	27.0	6.4	18.84	0.002	0.00	0.00	7.06	12.74	0.008	2.0	8.7	55
Asahi-ike	.. 7/IX	10.20	27.2	27.3	6.8	22.93	0.003	0.00	0.00	7.70	12.05	0.008	2.8	6.5	—
Tega-numa	1957 9/X	11.30	21.0	19.0	7.4	19.0	0.005	0.19	0.001	12.84	11.14	0.05	6.57	7.5	5
Ushiku-numa	.. 9/X	14.10	25.5	22.0	6.8	18.6	0.01	0.00	0.005	11.13	7.60	0.005	6.01	7.5	5
Tatara-numa	.. 10/X	16.20	23.5	21.0	4.9	26.5	0.02	0.02	0.001	11.34	9.54	0.07	18.53	15.3	9
Jô-numa	.. 11/X	10.00	24.0	21.0	7.5	24.6	0.3	1.25	0.005	13.27	27.19	0.07	20.44	18.0	0
Kondo-numa	.. 11/X	13.00	26.0	22.0	6.6	12.0	0.1	2.0	0.001	13.27	13.00	0.04	13.6	25.0	2
Inba-numa	.. 16/X	14.00	27.0	24.5	6.8	23.3	0.1	0.00	0.005	12.41	8.61	0.04	12.82	9.5	28
Tanega-ike	1958 15/VIII	10.30	24.8	25.8	5.5	25.65	0.001	0.00	0.000	5.35	1.18	0.08	3.60	5.0	29
Nenbutsu-ike	.. 15/VIII	13.40	24.0	12.0	6.6	21.19	0.001	0.00	0.006	22.47	1.69	0.008	6.09	4.5	12
Moto-ike	1957 3/IX	13.40	19.0	20.3	4.9	28.3	0.03	0.00	0.005	3.64	2.19	0.12	1.4	4.0	10

Shibu-ike	..	3/IX	14.40	21.0	21.0	4.5	44.2	0.1	0.00	0.000	3.00	1.52	0.03	1.1	1.5	19
Hyotan-ike	..	4/IX	11.00	16.0	20.0	4.9	35.8	0.25	0.00	0.005	2.57	1.52	0.55	1.2	1.5	15
Kido-ike	..	4/IX	12.00	16.0	20.0	5.1	15.8	0.01	0.00	0.005	17.76	3.71	0.01	6.0	2.0	15
Misumi-ike	..	4/IX	13.10	17.0	24.0	5.1	11.4	0.03	0.00	0.005	0.86	2.53	0.03	1.2	0.5	10
Ko-ike	..	4/IX	13.40	17.0	20.3	5.0	17.8	0.03	0.00	0.005	1.93	2.19	0.04	1.2	3.5	11
Naga-ike	..	4/IX	14.10	17.0	20.5	4.9	22.8	0.03	0.00	0.005	2.35	2.19	0.02	1.0	0.5	17
Shimono-koike	..	4/IX	14.50	18.0	25.0	5.0	19.2	0.01	0.00	0.005	0.43	1.69	0.01	1.2	0.1	22
Hasu-ike	..	4/IX	16.00	17.5	24.0	5.1	22.8	0.17	0.00	0.005	4.92	3.04	0.05	1.3	6.5	21
Kanori-ike	1959	4/VI	10.10	17.0	21.5	5.5	19.26	0.001	0.00	0.005	13.91	2.85	0.01	5.2	12.8	36
Waku-ike	..	4/VI	13.15	21.7	22.6	7.5	39.12	0.003	0.00	0.001	18.19	6.92	0.01	58.50	145.5	0
Okemi-ike	..	4/VI	16.10	20.5	22.0	6.7	13.84	0.003	0.00	0.000	8.13	2.20	0.08	3.2	18.5	55
Matsubara-chôko	..	3/VI	12.30	21.5	16.3	6.8	13.24	0.003	0.22	0.000	22.47	2.20	0.01	8.4	36.7	—
Oshidenoumi	..	3/VI	11.00	21.5	20.6	5.5	25.28	0.005	0.00	0.000	13.91	2.87	0.15	8.01	36.0	21
Zuminoki-ike	..	3/VI	12.00	22.4	21.6	5.5	17.46	0.003	0.00	0.000	18.19	2.20	0.03	8.82	34.5	16
Kotsutsumi-nishi-ike	1958	15/VI	16.00	29.5	30.0	4.9	26.54	0.01	0.00	0.000	1.71	6.25	0.004	1.00	2.8	112
Mikawa-ôike	..	15/VI	16.50	30.5	28.7	5.0	31.60	0.008	0.00	0.000	3.42	0.81	0.003	3.40	9.5	64
Biwaga-ike	1959	21/V	13.30	27.5	28.0	5.5	31.30	0.008	0.00	0.0005	5.14	14.35	0.07	10.41	28.5	49
Ishigaki-ike	1957	7/XI	13.30	24.5	22.0	5.1	14.5	0.001	0.00	0.000	1.93	7.60	0.01	1.68	1.0	112
Jôdo-shimo-ike	..	7/XI	16.30	19.5	19.0	5.1	18.3	0.001	0.00	0.000	2.14	5.57	0.008	1.20	1.5	64
Fuse-ike	..	19/VI	11.00	30.0	30.5	5.0	15.4	0.001	0.00	0.0005	1.50	4.52	0.06	1.2	3.0	127
Umadame-ike	..	25/VI	13.40	26.0	26.0	5.0	17.7	0.005	0.00	0.0005	4.71	4.17	0.3	0.8	2.2	66
Shinohara-ike	..	2/VII	9.00	25.5	25.0	4.9	12.7	0.008	0.05	0.0005	6.85	5.82	0.3	4.6	7.0	103
Fuse-minami-ike	..	19/VI	12.30	28.5	32.0	4.9	10.6	0.005	0.00	0.0005	5.56	2.78	0.07	1.0	9.0	65
Shibahara-minami-ike	..	25/VI	13.00	29.0	27.5	6.5	17.1	0.005	0.00	0.000	1.50	7.42	0.2	2.0	3.0	51
Kojoro-ike	1958	25/V	11.20	17.5	16.0	4.9	32.86	0.03	0.00	0.0008	0.86	2.20	0.04	0.4	3.7	25
Takaraga-ike	1957	21/V	13.45	24.0	24.5	5.9	24.5	0.25	0.00	0.01	3.85	3.13	0.05	2.4	0.8	79
Ko-ike	..	19/V	13.00	26.0	22.5	6.7	14.7	0.2	0.35	0.005	5.35	6.78	0.05	1.7	5.5	41
Ikejiri-ike	..	23/V	13.30	26.5	26.0	7.1	46.1	0.005	0.00	0.01	5.35	5.38	0.006	7.0	0.7	40
Masuda-ike	1959	28/V	14.30	28.5	27.8	6.8	24.08	0.008	0.00	0.0005	2.78	8.61	0.04	4.4	31.8	54
Tanega-ike	1958	30/X	10.20	16.6	17.0	6.7	13.26	0.001	0.00	0.0005	4.71	20.48	0.001	1.2	12.5	0
Ukinuno-ike	..	29/X	9.45	18.5	17.5	7.1	17.34	0.002	0.00	0.0005	16.70	11.02	0.03	2.4	10.5	2
Torinosu-ike	1959	4/V	9.50	27.5	27.2	5.4	27.69	0.04	0.00	0.0005	4.92	11.82	0.04	6.17	9.7	42
Byakushi-ike	..	2/V	12.15	18.5	16.2	4.9	10.82	0.06	0.00	0.0005	3.00	2.20	0.01	0.8	1.2	12

lands; this is also the case in swamps some distance from the coast. The calcium content is usually below 10 mg per litre, but less than this in swamps surrounded by moorland, where it was found to be below 5 mg per litre. The Jô-numa, Tatara-numa, and Kondo-numa located in the Kanto plain yielded 20 mg per litre; this is probably due to the drainage from cotton mills or rice fields. From studies made by S. YOSHIMURA, the large content of Waku-ike is exceptional and the pond is called thiotrophic fazies, a modification of the eutrophic type. The iron content is generally 0.01–0.09 mg per litre, but is more than 0.1 mg per litre in some swamps containing a fairly large amount of humus. The sulphate content is 10–20 mg per litre, but there is a large amount in exceptional cases. The species found frequently in the swamps and ponds are listed below:

Spirotaenia condensata
Netrium digitus
N. .. var. *Nägelii*
Penium margaritaceum
P. polymorphum
P. spirostriolatum
Closterium intermedium
Cl. libellula var. *intermedium*
Cl. littorale
Cl. setaceum
Cl. dianae
Cl. cynthia var. *Jenneri*
Cl. striolatum
Pleurotaenium excelsum
Pl. nodosum
Pl. Trabecula
Pl. .. var. *rectum*
Cosmarium angulosum
C. binum
C. Blyttii
C. contractum
C. .. var. *ellipsoideum*
C. .. var. *minutum*
C. depressum
C. exiguum
C. geminatum
C. granatum
C. hammeri var. *protuberans*
C. impressulum
C. margaritiferum
C. obsoletum
C. ocellatum
C. pseudopyramidatum
C. sexangulare f. *minima*
C. subturgidum f. *minor*
C. succisum
C. amoenum
C. pachydermum
C. connatum
Arthrodesmus convergens
A. extensus
A. octocornis
Xanthidium antilopaeum
X. cristatum var. *uncinatum*
X. acanthophorum
Euastrum denticulatum
E. ansatum var. *pyxidatum*
E. sinuosum var. *scrobiculatum*
Micrasterias crux-melitensis
M. decemdentata
M. pinnatifida
Staurastrum apiculatum
St. arachne
St. dejectum
St. Dickiei var. *circulare*
St. dilatatum
St. duacense
St. asteroideum var. *nanum*
St. muticum
St. orbiculare var. *depressum*
St. teliferum
St. tetracerum
St. sexangulare var. *subglabrum*
St. furcatum
Hyalotheca dissiliens
H. .. var. *tatrica*
Sphaerozosma granulatus
Desmidium aptogonum
D. Baileyi
D. coarctatum
D. swartzii
Gymnozyga moniliformis

So-called brown-water lakes and swamps are found to exist particularly in Hokkaido, and in the northernmost part of Hondo, and in special areas of mountainous regions. The nature of the waters is remarkable, containing large amounts of humus, iron, and ammonia. The humus-content is suggested by the consumption of $KMnO_4$. The iron-content is about 0.1–0.55 mg per litre, and the nitrogenous compound is 0.1–0.5 mg per litre in state of ammonia, but very poor in nitrate state. The consumption of $KMnO_4$ is usually more than 20 mg per litre. Thus, these brown lakes and swamps are in a highly advanced form of destrofication than swamps and ponds.

3. *Sphagnum*-moor and its bog: There were many *sphagnum*-moors in the northern part of Japan, and since moors in lowland plains were already cultivated and changed into rice-fields and other fields, some still remained as relics of their natural condition in the northern and eastern part of Hokkaido, and in parts of Hondo. However there are still many *sphagnum*-moors in the high mountainous regions, especially along the Nasu volcanic range, and on the Hida mountains in northern and central Japan. These *sphagnum*-moors lie chiefly along the ridges and northern slopes of the mountain, or in the basin surrounded by high mountains. There are many bogs or pools in the *sphagnum*-moors, and these bogs are arranged regularly in a stair-like manner on gentle slopes, or in the plain of basins. These bogs are furnished with a zone of *Menyanthes trifoliata* at their margin, and water plant communities are composed of *Potamogeton*, *Nymphaea*, *Brassenia*, and *Sparganium glomeratum*. There are communities of *Scirpus* or *Juncus* and *Menyanthes* in shallow bogs. The landscape florescence of these juncaceous plants are called in Japanese "Kaminota," "Onaeshiro," "Mitanohara," and "Senninta," by the natives, and mean 'the rice-fields cultivated by the God of the mountain'. The bog water are sometimes clear, but sometimes appear brownish (rarely dark brown) in appearance. The pH value of the bog-water is 4.5–5.0, and the consumption of $KMnO_4$ is shown to be 20–70 mg per litre; however in some cases such as bogs filled with clear water the consumption of $KMnO_4$ is less than 20 mg per litre. The nitrogenous compound, as shown in NH_4–N, has two types of content: 0.01–0.08 mg per litre, and 0.1–0.5 mg per litre. This type corresponds also to the type of iron-content in the bog-water. The *sphagnum*-bogs are poor in general in ammonia, but the type which has much ammonia is often seen in brown-coloured water; those in which much iron is contained are also seen sometimes in the same water. The iron content in the brown water are sometimes more than 0.09–0.9 mg per litre, however there are some exceptions, where the content of iron is only 0.01–0.03 mg per litre. The content of iron is divided into two types from 0.005–0.05 mg per litre to 0.09–0.9 mg per litre. The contents of nitrate and phosphate are extremely poor in *sphagnum*-bog water. The chloride is generally less than 3 mg per

Table 4. The chemical constituents of the bog-waters of *sphagnum* moors (mg. per litre)

Name of *sphagnum*-bog	Date of sampling	Hour	Air temperature	Water temperature	pH	O_2 cc/l	Consumption of $KMnO_4$	NH_4–N	NO_3–N	PO_4–P	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Sanno-numa of Daisetsu	1957 28/VII	9.50	22.0	19.0	4.7	6.02	51.7	0.2	0.00	0.000	0.43	1.69	0.09	0.8	4.0	45
Shino-numa of Daisetsu	.. 28/VII	11.00	23.0	18.0	4.8	6.19	35.0	0.04	0.00	0.0005	0.64	1.18	0.00	0.8	4.5	34
Gono-numa of Daisetsu	.. 28/VII	12.00	21.0	19.0	4.7	6.51	45.1	0.08	0.00	0.0005	0.43	1.69	0.00	0.8	4.0	40
Kumoigahara of Daisetsu	.. 27/VII	16.30	24.0	23.5	4.7	5.18	68.5	0.5	0.00	0.001	0.64	2.70	0.35	1.2	4.0	31
Suiren-numa of Hakkoda	1958 28/VII	9.15	17.5	18.3	4.8	5.46	51.82	0.09	0.00	0.0005	2.14	1.86	0.05	1.4	1.2	56
Kenashitai of Hakkoda 1	1959 17/VII	8.45	17.9	18.0	4.8	5.62	54.26	0.2	0.00	0.0005	2.14	0.88	0.01	1.0	20.5	57
Kenashitai of Hakkoda 2	.. 17/VII	9.20	18.8	18.0	4.7	5.71	45.91	0.1	0.00	0.0005	2.57	0.88	0.01	0.8	15.5	31
Yatsumanako of Iwate	1958 17/VII	14.30	24.5	30.0	4.4	5.75	61.43	0.2	0.00	0.000	0.64	1.58	0.05	0.8	2.8	20
Hachimantai	.. 19/VII	10.00	18.2	16.8	4.6	3.67	49.93	0.09	0.00	0.000	0.21	1.18	0.25	1.0	2.5	60
Ôyachi of Hachimantai	.. 19/VII	15.20	22.0	25.7	4.5	6.30	44.24	0.17	0.00	0.0005	1.50	1.52	0.00	0.8	2.2	51
Kurikoma 1	.. 15/VII	16.15	22.5	32.6	4.6	8.40	79.63	0.12	0.00	0.000	1.93	1.69	0.02	1.0	1.5	29
Kurikoma 2	.. 16/VII	13.20	26.5	31.5	4.1	—	28.31	0.08	0.00	0.0005	1.07	1.01	0.02	1.0	4.5	10
Gassan 1 (Midagahara)	1959 31/VII	15.45	17.5	18.4	4.5	6.70	42.93	0.1	0.00	0.000	1.07	0.61	0.01	0.8	5.5	31
Gassan 2 (Midagahara)	.. 1/VIII	8.10	21.5	18.4	4.5	6.02	33.98	0.09	0.01	0.000	0.64	0.61	0.03	1.2	7.5	54
Sugigamine of Zawo	.. 3/VIII	9.40	23.5	23.7	4.7	6.05	55.45	0.17	0.00	0.000	1.71	0.68	0.03	0.8	13.5	31
Benten-ike of Takahara	.. 1/IX	11.50	25.2	21.5	4.8	5.04	38.16	0.08	0.00	0.000	3.85	2.58	0.2	0.8	18.5	24
Kakumanbuchi of Akagi	.. 14/VIII	13.15	18.7	18.0	4.6	6.86	19.08	0.02	0.00	0.000	4.71	0.88	0.005	1.6	9.5	33
Yashima-ike (Kirigamine)	1957 18/X	12.40	8.5	11.0	5.0	12.24	25.3	0.005	0.00	0.000	5.35	1.35	0.04	0.8	1.5	51
Kamaga-ike (..)	.. 18/X	14.15	9.5	10.5	5.0	11.2	18.1	0.001	0.00	0.000	5.56	1.35	0.04	0.4	1.7	63
Onigaizumi (..)	.. 18/X	15.15	7.5	9.5	5.0	10.50	14.5	0.001	0.00	0.001	5.99	1.35	0.05	0.9	1.5	51
Ayamedaira (Oze)	1958 2/IX	8.50	16.5	16.8	4.7	5.60	33.83	0.08	0.00	0.0005	0.64	1.35	0.05	1.0	0.8	33

Name of *sphagnum*-bog		Date of sampling	Hour	Air temperature	Water temperature	pH	O_2 cc/l	Consumption of $KMnO_4$	NH_4–N	NO_3–N	PO_4–P	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Fujimi-ike (Oze)	..	2/IX	9.40	17.4	21.0	4.7	5.04	47.71	0.07	0.00	0.0005	2.35	1.52	0.25	0.8	2.0	—
Kamitashiro (Oze)	..	3/IX	12.20	19.5	21.0	4.8	5.82	22.93	0.008	0.00	0.0005	0.43	0.84	0.01	0.8	1.2	35
Nakatashiro (Oze) 1	..	2/IX	16.10	17.0	22.0	4.8	6.58	34.08	0.03	0.00	0.0008	0.21	0.51	0.01	0.4	0.8	48
Nakatashiro (Oze) 2	..	3/IX	14.00	20.0	22.2	4.5	4.22	52.05	0.09	0.00	0.001	1.71	0.51	0.05	0.8	7.5	42
Shimotashiro (Oze)	..	3/IX	9.00	17.0	20.0	4.7	5.04	34.08	0.07	0.00	0.0005	0.86	1.35	0.02	0.7	2.5	25
Shirasuna (Oze)	..	4/IX	8.25	18.4	19.0	4.7	4.34	35.63	0.25	0.00	0.001	0.64	1.01	0.01	0.6	6.5	47
Nushiri-daira (Oze)	..	4/IX	9.20	19.0	19.3	4.6	4.48	37.18	0.09	0.00	0.0005	0.64	0.84	0.01	0.4	1.5	48
Takayachi (Myoko) 1	..	13/VIII	15.00	13.0	21.5	5.0	5.90	27.80	0.06	0.00	0.000	1.07	0.84	0.005	1.0	2.2	45
.. .. 2	..	13/VIII	16.00	12.8	19.5	4.9	6.72	36.97	0.06	0.00	0.0005	1.07	0.84	0.01	1.2	2.5	19
Kurosawano-ike	..	14/VIII	8.30	15.5	16.4	4.7	5.30	40.76	0.1	0.00	0.0008	1.07	1.01	0.02	1.6	2.2	37
Moor-bog of Shirouma	..	10/VIII	8.45	15.0	25.0	5.0	5.32	18.33	0.01	0.00	0.000	1.28	1.18	0.01	0.4	2.8	38
Tengunohara	..	10/VIII	11.40	18.2	18.5	4.8	6.62	40.45	0.05	0.00	0.0005	0.86	0.84	0.005	0.4	1.6	46
Tsuga-daira	..	10/VIII	13.40	20.8	18.5	4.5	5.98	47.40	0.15	0.00	0.000	1.07	0.51	0.005	0.8	2.3	54
Moor-bog of Seijô-cottage	..	11/VIII	8.00	20.5	18.5	4.9	5.19	47.40	0.23	0.00	0.000	1.07	1.18	0.005	0.6	2.0	45
Kamino-tanbo	..	11/VIII	9.00	23.0	22.6	4.5	4.43	51.19	0.4	0.00	0.000	1.07	1.18	0.04	0.8	2.8	34
Midagahara (Tateyama) 1	..	19/VIII	12.00	20.0	18.7	4.3	5.44	62.57	0.45	0.00	0.000	2.14	1.35	0.03	0.6	3.8	15
.. .. 2	..	19/VIII	13.30	21.0	20.5	4.6	5.90	37.09	0.09	0.00	0.0005	1.28	1.35	0.005	0.8	4.0	38
Murodo-daira (Tateyama)	..	19/VIII	16.15	15.3	19.8	4.3	6.58	19.97	0.03	0.00	0.000	1.28	1.35	0.03	0.6	3.5	20
Shijuhachi-ike 1	1957	3/IX	12.00	22.5	22.0	4.8	10.47	37.9	0.35	0.00	0.0005	0.64	2.19	0.04	0.4	1.0	52
.. 2 (Shigakogen)	..	3/IX	12.30	22.0	21.0	4.7	11.23	33.2	0.06	0.00	0.0005	1.07	2.19	0.05	1.0	0.5	48
Yakumogahara (Hira) 1	..	26/V	9.40	11.0	11.0	5.1	8.64	23.9	0.001	0.00	0.000	6.42	4.17	0.04	1.6	0.3	35
.. .. 2	..	26/V	10.15	11.5	11.2	5.0	7.43	20.9	0.000	0.00	0.000	1.07	2.52	0.9	1.3	0.1	27
Koshiki-ike (Kirishima)	1959	2/V	9.10	14.5	12.0	4.9	7.84	14.45	0.08	0.00	0.0005	3.64	0.84	0.01	1.2	1.8	14

litre, but is slightly more in bog-water having inflowing water or springs. The *sphagnum*-bog which lie in the coastal line are somewhat large in chloride content. The calcium contents are generally less than 2 mg per litre, but are slightly greater in the case of moor-bog supplied by the springs; however, it is not greater than the content of swamp-water. The silica contents are usually 0.5–2 mg per litre, but are about 3–6 mg per litre in the case of moor-bogs that have inflowing water. In fact, moor waters generally show a moderately acidic reaction in pH value. The consumption of $KMnO_4$ is in general large, and all the anorganic nutrients are small, but the ammonia is not always small in every case. The contents of ammonia correspond to the amount of eutrophic water, as already pointed out by S. YOSHIMURA. The analytical results of the waters of *sphagnum*-bogs studied by the writer and the Desmids found in these *sphagnum*-bogs are shown in table 4 and 5 respectively.

Table 5. The list of Desmids found frequently in *sphagnum* bogs of Japan

Spirotaenia condensata	*C. globosum*	*E. sinuosum* var. *gangense*
Cylindrocystis crassa	*C.* .. f. *minor*	*E. binale* var. *minus*
Netrium digitus	*C. quadrifarium* f. *hexasticha*	*Micrasterias truncata*
N. .. var. *Nägelii*	*C. decedens*	*Staurastrum Hystrix*
N. oblongum	*C. pseudopyramidatum*	*St. apiculatum*
Penium polymorphum	*C. venustum* f. *minor*	*St. orbiculare* var. *depressum*
P. silvae-nigrae	*C. subtumidum*	*St. Simonyi*
Closterium littorale	*C. obliquum* f. *tatrica*	*St. scabrum*
Cl. striolatum	*Arthrodesmus incus* f. *minor*	*St. glabrum*
Cl. intermedium	*A. extensus*	*St. hirsutum*
Pleurotaenium minutum	*Xanthidium armatum*	*St. margaritaceum*
Pl. .. var. *crassum*	*Euastrum crassum*	*St. inconspicuum*
Docidium undulatum	*E. cuneatum*	*St. wandae* var. *brevispinum*
Tetmemorus laevis	*E. montanum*	*Hyalotheca dissiliens*
T. granulatus	*E. gnathophorum*	*H.* .. var. *tatrica*
Cosmarium cucurbita	*E. sublobatum*	*Gymnozyga moniliformis*

4. Reservoirs and artificial ponds: These reservoirs and ponds are constructed for the irrigation of rice-fields, and are utilized also for fish-breeding in spare time. For these purposes the water-level is severely changed, and dried up for drainage at times after a long drought; they are filled with inflowing water in the spare time of winter. Consequently the nutrient substances are changed with the alteration of water, and by supplying manure or feed (such as pupa of silk-worms) for fish-breeding. Thus there is none at all, or only a poor community of free-floating water plants under these unstable conditions, because of the mechanical changes made

Table 6. The water analysis of artificial reservoirs of Japan (mg per litre)

Name of reservoir	Date of sampling	Hour	Air temperature	Water temperature	pH	Consumption of $KMnO_4$	NH_4-N	NO_3-N	PO_4-P	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Ôsawanai-tameike	1958 24/VII	12.10	27.0	27.6	5.4	33.50	0.005	0.00	0.001	8.99	11.55	0.05	2.0	5.8	13
Fujieda-tameike	.. 24/VII	13.40	28.0	27.0	7.0	22.75	0.001	0.00	0.001	9.42	22.21	0.005	2.0	4.5	10
Kiyohisa-tameike	.. 24/VII	14.45	25.5	28.0	6.5	32.86	0.01	0.00	0.001	1.71	16.72	0.03	2.4	45.5	13
Ninosawa-tameike	.. 24/VII	16.00	26.5	29.7	6.5	43.61	0.03	0.00	0.001	2.14	29.78	0.03	2.0	5.3	21
Hakamagata-ike	.. 25/VII	12.50	27.4	27.5	7.2	23.64	0.005	0.00	0.001	10.27	32.53	0.008	3.6	6.5	0
Ushigata-ike	.. 25/VII	14.40	24.7	26.0	7.2	21.11	0.003	0.00	0.001	14.34	36.49	0.01	4.4	7.5	9
Ô-tameike	.. 25/VII	16.20	27.0	27.0	6.8	29.70	0.005	0.00	0.001	4.07	47.51	0.02	2.8	6.2	2
Ôishitano-ôtsutsumi	.. 1/VIII	13.40	29.0	28.5	6.6	35.39	0.02	0.00	0.000	8.99	6.25	0.08	2.0	2.5	14
Bagyu-numa	.. 3/VIII	12.00	31.5	29.5	6.4	32.22	0.005	0.00	0.001	4.28	9.62	0.02	7.2	17.5	—
Nanko	.. 14/VII	15.20	27.2	27.5	6.9	26.04	0.005	0.00	0.0005	4.71	7.94	0.01	9.2	10.5	3
Sarugababa-ike	1959 4/VI	11.10	20.5	19.8	6.4	10.23	0.003	0.00	0.0005	4.49	2.20	0.005	2.0	18.5	4
Saino-ike	1958 7/IX	11.00	27.5	27.0	6.5	21.69	0.001	0.00	0.000	7.28	12.05	0.02	4.4	9.2	30
Nagamine-ike	.. 7/IX	11.50	25.2	27.1	7.2	16.73	0.001	0.01	0.001	9.42	19.80	0.01	5.6	4.5	11
Iwaga-ike	.. 15/VI	14.00	28.5	28.5	5.1	34.76	0.01	0.00	0.001	0.86	7.60	0.005	2.6	6.5	31
Sasaga-ike	.. 15/VI	14.45	30.5	28.8	5.1	25.53	0.005	0.00	0.001	2.14	8.95	0.001	6.01	9.8	—
Chokushi-ike	1959 21/V	15.15	25.5	26.6	5.1	18.66	0.003	0.17	0.0005	4.92	6.92	0.03	2.4	24.5	10
Nyakoji-ike	.. 21/V	16.00	28.6	24.5	5.4	16.85	0.003	0.18	0.0005	2.78	9.20	0.03	3.2	23.5	—
Haraigawano-ike	1957 7/XI	16.00	23.8	19.0	5.1	19.20	0.08	0.4	0.000	6.42	6.92	0.01	1.36	3.2	8
Jôdo-ike	.. 7/XI	17.00	19.3	17.5	5.1	17.10	0.001	0.00	0.000	3.21	5.07	0.005	1.04	1.0	5
Dohaku-ike	.. 8/XI	10.10	18.5	18.0	5.1	14.5	0.001	0.00	0.0005	3.85	4.73	0.02	0.96	0.8	6
Nara-ike	.. 8/XI	10.50	23.0	18.0	5.1	19.6	0.2	0.00	0.0005	2.57	16.89	0.01	1.2	2.2	7
Tsuga-ike	.. 8/XI	14.40	23.5	18.0	5.1	9.5	0.1	1.8	0.000	4.49	5.74	0.005	2.56	3.4	0
Ôsawano-ike	.. 16/V	12.00	21.0	22.0	6.8	16.2	0.005	0.00	0.0005	3.60	6.26	0.01	9.6	5.0	7
Hirosawano-ike	.. 16/V	13.00	25.5	24.5	7.4	27.4	0.001	0.00	0.0005	4.07	8.95	0.005	10.0	4.0	5
Shakuhachi-ike	.. 19/V	11.00	25.0	21.5	6.6	10.9	0.000	0.00	0.001	6.42	4.17	0.03	2.8	0.9	6

Table 6. The water analysis of artificial reservoirs of Japan (Continued)

Name of reservoir	Date of sampling	Hour	Air temperature	Water temperature	pH	Consumption of $KMnO_4$	NH_4-N	NO_3-N	PO_4-P	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Mizoroga-ike	1957 19/V	14.30	27.0	23.0	6.9	12.1	0.000	0.03	0.006	2.35	7.13	0.05	6.0	8.5	14
Minakami-ike	1958 13/V	14.00	21.5	23.5	6.8	41.71	0.008	0.00	0.001	2.99	9.20	0.02	4.8	4.5	4
Konabe-ike	.. 13/V	14.30	23.0	22.8	6.6	32.23	0.15	0.00	0.005	3.64	6.92	0.09	1.84	0.4	0
Uwanabe-ike	.. 13/V	15.15	26.0	25.5	8.0	45.25	0.35	3.5	0.004	7.49	6.80	0.02	4.4	0.7	0
Sarusawano-ike	.. 13/V	11.30	22.0	21.5	7.8	27.18	0.01	0.8	0.001	8.77	6.25	0.03	4.4	1.7	3
Dorogadani-ike	1958 6/V	10.30	19.5	20.0	6.9	19.59	0.01	0.95	0.000	2.35	12.50	0.04	10.82	14.5	—
Nono-ike	.. 6/V	11.30	23.0	20.0	7.1	18.01	0.01	0.05	0.000	3.42	9.46	0.04	7.21	6.5	3
Kannon-ike	.. 6/V	12.30	22.0	22.0	7.3	15.48	0.002	0.00	0.000	4.49	9.38	0.04	5.01	4.5	0
Kyono-ike	.. 6/V	13.30	22.5	19.5	7.0	18.96	0.03	0.07	0.000	2.57	9.46	0.02	4.2	4.2	0
Shindenno-ôike	.. 6/V	15.00	22.8	19.8	6.9	17.32	0.02	0.06	0.000	1.50	10.47	0.03	2.0	4.2	—
Mizoasa-ike	.. 18/V	9.40	24.0	20.8	7.1	23.89	0.12	0.035	0.000	1.71	10.98	0.04	10.98	11.5	6
Naganori-ike	.. 18/V	10.40	22.6	21.5	7.1	22.12	0.05	0.6	0.0005	1.71	11.82	0.03	7.21	7.5	0
Hirotani-ike	.. 18/V	11.40	23.5	22.0	7.1	18.71	0.02	0.00	0.000	3.64	2.61	0.03	5.37	4.5	0
Senba-ike	.. 18/V	14.10	25.2	23.5	6.8	21.11	0.06	0.035	0.000	1.71	10.98	0.02	4.97	4.5	—
Naga-ike	1959 28/V	11.15	29.5	26.0	6.1	15.05	0.001	0.00	0.0005	7.90	5.32	0.01	1.2	32.5	0
Izumi-ike	.. 28/V	12.00	27.5	25.2	6.8	20.46	0.005	0.00	0.0005	8.13	7.94	0.04	4.4	23.5	—
Gongen-ike	.. 28/V	12.35	28.5	27.0	6.8	13.84	0.003	0.12	0.0005	7.90	5.32	0.03	3.6	33.0	—
Benten-ike	.. 28/V	15.15	27.7	27.4	5.5	21.67	0.005	0.00	0.000	3.00	8.52	0.01	3.6	34.5	28
Banryu-ko (Shimo-ike)	1958 28/X	16.40	15.0	17.2	6.4	19.83	0.005	0.00	0.000	8.77	23.93	0.07	0.96	10.5	4
.. (Kami-ike)	.. 28/X	17.10	14.5	17.0	6.5	17.34	0.005	0.00	0.0005	9.6	20.83	0.08	1.2	12.5	14
Sumiyoshi-ike	1959 8/V	15.30	35.4	33.6	5.5	14.75	0.04	0.00	0.001	18.19	4.39	0.05	5.85	10.5	0
Ôtsubo-ike	.. 4/V	10.30	30.2	25.4	6.8	25.52	0.4	0.2	0.001	1.07	7.26	0.01	4.81	7.8	1
Shirakumo-ike	.. 9/V	12.10	19.5	19.0	5.4	14.45	0.003	0.00	0.000	8.13	4.39	0.03	4.0	8.8	—

by human hands. The reservoirs are in some cases constructed by the improvement of the natural swamps, and in such reservoirs the vegetation of water plants are partly developed. The analytical results of these reservoirs by the writer are shown in table 6. The pH value is 5.0-7.2, but is sometimes shown over 7.4 in reservoirs growing water-blooms. The soluble nitrogenous compounds are generally greater in ammonia than in the state of nitrate, and the soluble nitrogen of the ammonia state is 0.005-0.05 mg per litre sometimes 0.15 mg per litre. On the other hand, the nitrate in some cases is surpassed by the amount of ammonia. The chloride is often more than 30 mg per litre in coastal regions, such as the Tsugaru Peninsula, but is in general about 10 mg or less per litre. The iron contents are usually 0.005-0.05 mg, but in some cases 0.07-0.08 mg per litre. The calcium contents are generally below 10 mg per litre. The soluble phosphate is poor in every reservoir. The silica and sulphate contents appear in varying degrees, but are large in some ponds surrounded by cultivated fields. The Desmid-flora in reservoirs and artificial ponds are poor and few in number of species, because of the instable condition, and the epiphytic nature of desmids. True planktonic desmids are also few in number of species, but some remarkable species are found in the central part of Hondo. They are as follows:

Gonatozygon monotaenium	var. *Wallichii*	*Hyalotheca dissiliens*
Triploceras gracile	*Staurastrum arctiscon*	*Desmidium aptogonum*
Pleurotaenium Trabecula	*St. sexangulare* var. *subglabrum*	*D. coarctatum*
Xanthidium hastiferum	*St. limneticum* var. *Burmense*	*D. Swartzii*
var. *curvispinosum*	*St. tohopekaligense*	*Sphaerozosma granulatus*
Micrasterias alata	*St. tetracerum*	*S. vertebratum*
M. mahabuleshwarensis	*St. leptocladum*	*Gymnozyga moniliformis*

5. Alpine lakes and ponds: The writer studied some of the lakes and ponds in the subalpine and alpine regions of the Nasu volcanic range and the Hida mountains. The surrounding areas are sometimes rocky and bare land, and sometimes alpine meadows. There is no water plant, but merely a mass of *sphagnum* or mosses, partly along their bare shores. The ponds lie at a low altitude, and are surrounded by vegetation of shrubs and trees. The analytical results of these lakes and ponds made by the writer and other investigators are shown in the table 7. The anorganic nutrients are poor, and their amounts fairly correspond to the water of *sphagnum*-bogs or pools, but in some ponds of the volcanic regions, such as Mt. Iwate and Mt. Norikura, the contents of calcium and sulphate are somewhat larger than others. The consumption of $KMnO_4$ is generally small, with the exception of the Ohniu Pond. The Ohniu pond lies in the subalpine region

Table 7. The chemical constituents of lakes and ponds in the alpine and subalpine regions of Japan

Name of lake	Date of sampling	Hour	Air temperature	Water temperature	pH	Consumption of $KMnO_4$	NH_4-N	NO_3-N
Onaeshiro-ko (Iwate)	1958 17/VII	13 50	24 5	24 5	4.7	9.48	0.005	0.00
Okama-ko	.. 17/VII	14.20	24.0	22.0	4.2	11.38	0.02	0.00
Hachiman-numa	.. 19/VII	11.50	16.0	17.8	4.7	16.75	0.01	0.00
Goshiki-numa (Shirane)	1931 4/VI		15.2	8.7	5.2	0.7	0.05	0
Shirouma-ôike	1958 10/VIII	9.00	15.0	20.0	5.1	13.27	0.01	0.00
Happono-ike	1927 27/VI		12.7	0.9	5.4	5 76		
Mikuri-ike (Tateyama)	1958 18/VIII	15.50	15.6	15.0	5.0	10.43	0.03	0.00
Midori-ike (..)	.. 18/VIII	15 20	15.8	16.9	4.9	20.86	0.25	0 00
Gono-ike (Norikura)	1953 5/IX		8.5	11.1	5 2	0.10		
Ohniu-ike (..)	.. 10/IX		13 0	10.8	5.2	1.03		
Tsuruga-ike (..)	.. 5/IX		10.0	10.3	5.2	0.66		

Name of lake	PO_4-P	SiO_2	Cl	Fe	Ca	SO_4	Number of species	Investigator
Onaeshiro-ko (Iwate)	0.0005	13.91	2.24	0.02	4.2	14.2	4	HIRANO
Okama-ko	0.000	9.63	1.72	0.05	3.0	14.5	0	..
Hachiman-numa	0.000	1.5	2.20	0.005	0.8	3.2	0	..
Goshiki-numa (Shirane)	0.005	2.4	—	1.1	1.4	—	0	YOSHIMURA
Shirouma-ôike	0.000	1.06	2.2	0.02	0.8	2.5	6	HIRANO
Happono-ike		2.48	0.04				0	UÉNO & YOSHIMURA
Mikuri-ike (Tateyama)	0.000	0.86	0.51	0.03	0.8	3.9	0	HIRANO
Midori-ike (..)	0.000	1.28	1.69	0.09	0.8	7.3	14	..
Gono-ike (Norikura)		<0.64	1.17	—	0.57	4.3	5	TORII & others
Ohniu-ike (..)		8.35	1.24	—	5.49	11.3	18	.. ..
Tsuruga-ike (..)		<0.64	1.60	—	3.89	3.8	8	.. ..

of Mt. Norikura, and is a dammed lake; it always has an inflow of a considerable amount of water. The shore-bottom is covered by fallen leaves from the surrounding area. The desmid-flora of this pond is fairly rich, compared with the other pond; this is probably due to the nutrient substances brought by the decayed leaves, and at the same time it is probably favourable to the epiphytic life of desmids. The true planktonic desmids are quite absent from every pond of high altitude. The Desmids found among the polsters of the mosses or *sphagna* and on the fallen leaves are listed below. (Table 8)

Table 8. The list of desmids found in alpine and subalpine lakes and ponds

Species	Onaeshiro-ko	Shirouma-ôike	Midori-ike	Gono-ike	Ohniu-ike	Tsuruga-ike
Cylindrocystis Brébissonii				+		
C. .. var. *minor*					+	+
Netrium digitus			+			
Penium polymorphum			+	+		+
P. silvae-nigrae						+
Tetmemorus laevis			+			
Pleurotaenium minutum		+				
Cosmarium anceps					+	
C. cucurbita	+					+
C. decedens						+
C. globosum f. *minor*	+		+			
C. nitidulum var. *subundatum*					+	
C. notabile var. *arcticum*					+	
C. petsamoense f. *simplicius*					+	
Arthrodesmus incus f. *minor*			+			

Species	Onaeshiro-ko	Shirouma-ôike	Midori-ike	Gono-ike	Ohniu-ike	Tsuruga-ike
Staurastrum dispar					+	
St. hirsutum			+		+	+
St. Hystrix			+			
St. margaritaceum			+			
St. mutilatum						+
St. punctulatum	+				+	+
St. .. var. *Kjellmani*					+	
St. Simonyi			+			
Euastrum binale var. *minus*			+			
E. cuneatum			+			
E. didelta					+	
E. humerosum	+					
E. montanum			+	+		+
E. sublobatum			+			
E. crassum					+	
Micrasterias thomasiana					+	
Sphaerozosma granulatus			+			

Factors relating to the distribution of Desmids

There are some factors concerning the distribution of Desmids that are of geohistorical formation, media of distribution such as by birds, wind and flood, changes of climatic conditions, and environmental conditions of waters containing desmid-life. We must fully understand the character of Desmids in relation to their living conditions. The writer compared the nature of waters and the character of desmid-species with the circumstances related in the above chapter. Here the writer considers the relation between nutrient substances and Desmids.

1. The relation between pH value and the species number of desmids

The extent of pH value found among many Desmids was confined chiefly to the 4.5–6.8, and the Desmids are relatively fewer in the extents of below 4.4 and over 7.2 of pH value; this relation is shown in figure 1.

The pH value of *sphagnum*-moor and its bog-water is generally 4.5–5.0, but rarely down to 4.1. The species number of Desmids found in the *sphagnum*-bogs is not shown; there is great variation in the extent of 4.5–5.0 in pH value, and its number is about from 30 to 60 in each bog; however there are conspicuously few in the *sphagnum*-bogs to the extent of 4.1–4.4 in pH value. Such a moor is exceptional, and further in the moor, where the waters show a strong acidic reaction below 4.0 (acidotrophic type), the Desmids do not exist at all or are very few in number of species. The moor-bogs showing strong acidic reaction, for instance 3.8 in moors of Mt. Kurikoma, Yoshigataira, and Gensei-numa are exceptional, as the spring-water comprised anorganic acid (chiefly sulphuric acid). The

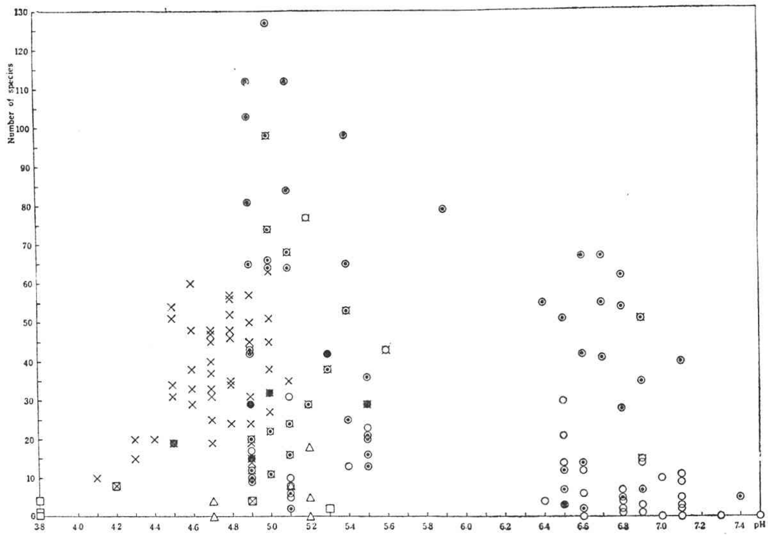


Figure 1. Relation between the pH value and the number of species.
×, *sphagnum*-moor; ⊙, swamp; ⊙ with ×, swamp with moor; ●, dystrophic pond; ○, reservoir; ○ with ×, reservoir with moor; □, pond showing acidotrophic type; ⊠, acidotrophic moor; △, alpine pond

species number of desmids is low (4 species) in such a strong acidic and specific moor-bog as that of Kurikoma, while other moor-bogs nearly are rich in desmids (29 species). The difference between this specific acidic moor-bog and other moor-bogs in analytical results of water is remarkable, and is shown in the following table:

Name	pH	Consumption of $KMnO_4$	NH_4-N	SiO_2	Cl	Fe	Ca	SO_4
Acidic moor-bog of Kurikoma	3.8	16.43	0.04	5.78	26.17	0.05	10.57	45.5
Other moor-bog of Kurikoma	4.6	79.63	0.12	1.93	1.69	0.02	1.00	1.5
Moor-bog of Mt. Gassan	4.5	42.93	0.1	1.07	0.61	0.01	0.8	5.5

The chief differences are the large content of chloride, calcium and sulphate, besides the strong acidic reaction in pH value. The contents of iron and ammonia are not so conspicuous as in other moor-bogs of various regions. The silica content is somewhat larger, compared with other moor-bogs, but this content corresponds with the swamps and streams. On the other hand the moor-bogs of Usagishima, near Nikko-Yumoto, is conspicuous in a large content of calcium and sulphate, but the contents of other nutrient substances are small and correspond with other moor-bogs. There is an instance in the Yoshiga-daira moor that the contents of chloride and calcium are small, and only the content of sulphate is large and conspicuous. These two moor-bogs of Usagishima and Yoshiga-daira are very poor in desmids. (Usagishima has 8 species and Yoshiga-daira none) The poor-conditioned desmid-flora of these two acidic moors is not only due to the strong acidic reaction of pH value, but the excess content of some anorganic substances. The pH value of swamps is, in general, wide, chiefly 4.9–5.5 and 6.4–6.9, but rarely up to 7.1. The swamps rich in Desmids (over 65 species or up to 120 species) shows an extent of 4.9–5.4 in pH value, and next in 6.4–6.9 in pH value (50–60 species). The swamps with neutral or weak alkaline are poor in Desmids, and those which exist in these waters are rapidly decreasing in number of species with the increase of alkali reaction.

2. The relation between the consumption of $KMnO_4$ and the species-number of desmids

The humus contents indicated by the consumption of $KMnO_4$ are, in general, small in the acidotrophic lakes, and alpine lakes or ponds, and the consumed $KMnO_4$ is below 10 mg per litre. The consumption of $KMnO_4$ generally shows an extent of 15–50 mg per litre in *sphagnum* moor-bogs, and the moor-bogs, indicating the consumption of $KMnO_4$ in extent of 15–20 mg per litre are generally filled with clear water, while the moor-bogs showing dark-brownish in appearance are over 50 mg or up to more than 80 mg per litre in consumption of $KMnO_4$. In swamps, the contents are generally 14–35 mg per litre, and are slightly inferior in content of humus when compared with the moor-bogs; but the Desmids are much richer than in the moor-bogs. It is a noteworthy fact that in swamps where over 100 species of desmides are found, two places in the waters showed a consumption of $KMnO_4$ 15 mg per litre. The swamps and moor-bogs which contained over 60 mg per litre in consumption of $KMnO_4$ are not always rich in Desmids, and the average number of species is 30. The circumstances which contained a moderate amount of humus gave a stable condition to desmid-life. and it meant also some formation of

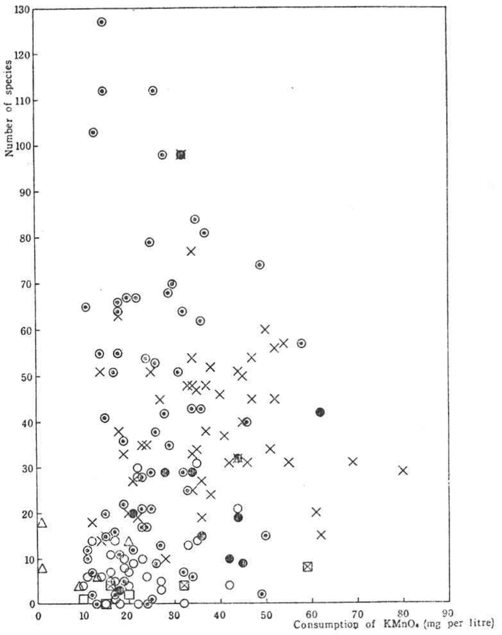


Figure 2. Relation between the consumption of $KMnO_4$ and the number of species

old swamps or ponds. The swamps are somewhat destroficated. The life of Desmids historically flourishes under moderate contents of nutrient substances, undisturbed circumstances, and old formations, and are rich in species-number under these conditions. On the other hand the reservoirs are in general instable, owing to repeated alterations of the water, and to the rapid change in the amount of nutrient substances, in spite of a moderate consumption of $KMnO_4$. The consumption of $KMnO_4$ in reservoirs does not always depend on the amount of humus, from but on the suspended substances the decaying of plankton-organisms. (figure 2)

3. The relation between calcium content and the species-number

The waters rich in Desmids are generally poor in calcium content without consideration of other nutrient substances. The bog-waters of the *sphagnum*-moor are poor in calcium content and up to 1.6 mg per litre, but there are some instances where the number of desmid-species in the swamps is about twice as many as in the same content of calcium, compared with *sphagnum*-bogs. In such swamps the other contents of nutrient substances are rich in chloride, and are about 2–4 times as much as that found in the *sphagnum*-bogs ; the iron, sulphate, and silica contents are not conspicuously different, but the consumption of $KMnO_4$ is rather smaller than in the *sphagnum*-bogs. Consequently the main difference between the swamp-water and the moor-water is in chloride, but the swamp-water is far richer in chloride content, while the reservoirs having the same content of calcium are very poor in Desmids. The calcium content of the reservoirs are up to 11 mg per litre, and the desmid-flora of the reservoirs is poor in every case, showing various amounts of calcium content. There are some instances where the swamps contained a greater amount of calcium (about 8 mg per litre) and these are rich in Desmids ; in the swamps of Hakuryu-ko and Izu-numa about 60 to 100 species of desmids can be found. It is confined to special places where the calcium content is fairly rich in the *sphagnum*-bogs. The calcium content is 8.65 mg per litre in the *sphagnum*-moor near

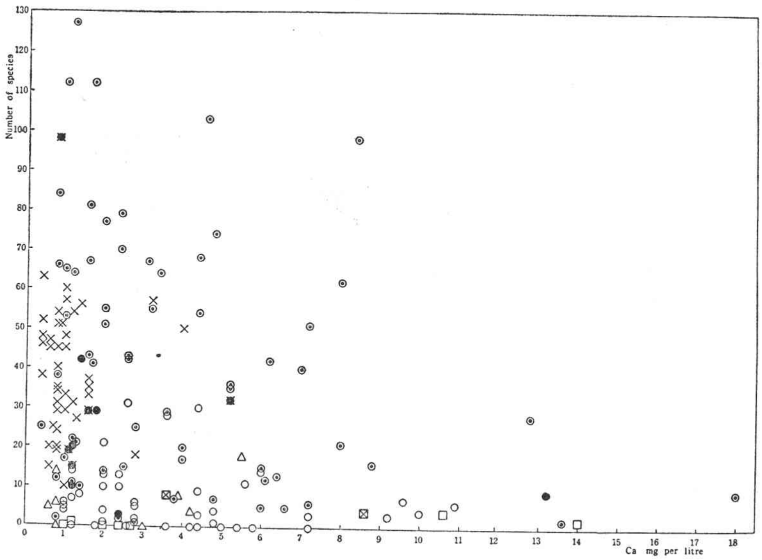


Figure 3. Relation between the calcium content and the number of species.

Yachi Hot springs in the Hakkoda mountains, and this is enormous in calcium content. Only 4 species are found there. The *sphagnum*-bog of Usagishima, Nikko-yumoto, belongs to a special instance in much content of calcium (3.6 mg per litre), and species found there are only 8 in number. The content of such an amount seems to be the limiting factor in desmid-life, when compared with others among the *sphagnum*-bogs. In such special places the moor-waters are, in varying degrees, comparatively rich in sulphate content. The content of calcium and sulphate containing these amounts in special places of Yachi Hot springs and the Usagishima moor, are generally in swamp water. Nevertheless the same contents of calcium and sulphate are rich in Desmids in swamp water, but poor in moor waters. Other contents of nutrient substances such as SiO_2, iron, sulphate, and the consumption of $KMnO_4$ in both waters, are not conspicuous in difference, but in chloride content. The chloride content of the Yachi Hot-spring moor and Usagishima is small, compared with the content of calcium. This fact seems to show that a great content of calcium does not limit desmid-life when a considerable amount of other nutrient substances are existing in the waters. The moor-waters are generally poor in nutrient substances, so that a small excess of calcium content affects desmid-life injuriously. Consequently Desmids are at their best in a small content of calcium in the inland waters of Japan, and a greater content of calcium is also suitable for Desmids when the amount of other substances are balanced with an increase of calcium content at least about 10 mg per litre, and waters in such condition permit the rich flora of desmids at the first step. Water particularly rich in calcium content, compared with the other nutrient substances, is a conspicuously bad condition, and limits the Desmids. Figure 3 show the relation between the content of calcium and the number of species.

4. The relation between chloride content and the species number

The minimum content of chloride in *sphagnum*-moor bogs is 0.5 mg per litre, but the chloride content of moor-waters observed in the writer's studies is generally up to 2 mg per litre. The species of Desmids in the water of chloride content of 0.5 mg per litre reaches to fifty. This place should be called rich in Desmids, and although the increase of chloride content is not shown to be so much, the increase of species can be found to the extent of 0.5-2.0 mg per litre of moor-water; there is a slight increase of about 10 species in such waters. This fact is the same in swamp-waters. In these moor-bog waters the other chemical constituents are all low in content. The swamps rich in Desmids contain 2–14 mg per litre in chloride content, and the species-numbers were calculated from 60 up to 127. Consequently chloride content seems to be suitable for desmid-life, to the extent of 0.5–14 mg per litre. While in the swamp-waters, the other chemical constituents are rich compared with the content of *sphagnum*-bog waters, and because of this it is doubtful whether desmid-life is really suitable or not in the case where swamp water is less in content of all other chemical constituents (except chloride) than in moor water. The desmid-species show a marked decrease in swamp waters which contained more than 16 mg per litre of chloride, and the writer found less than 20 species (with the exception of Haku-ryu-ko) keeping a high chloride content. This swamp was kept in its natural condition up to recent years, but is now surrounded by cultivated rice-fields, and is reduced in area year by year. The swamp water is mixed with the surrounding waters of the rice-fields at high water-level after the long rains, so that the swamp takes in manure constituents. There are many instances along the coastal plain of the Tsugaru peninsula which retains a chloride content of about 20 to 50 mg per litre, and the Desmid-flora is not so rich as in the swamp which lie far away from the sea-coast. The writer has found

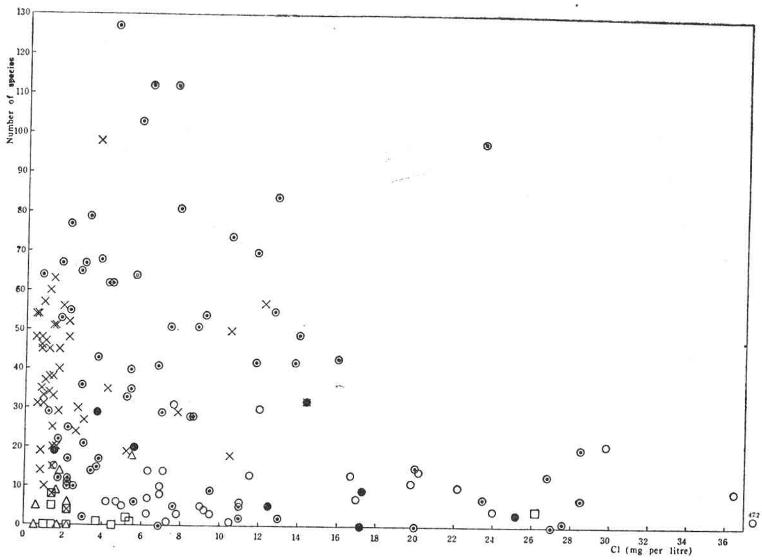


Figure 4. Relation between the content of chloride and the number of species.

in such places up to about 20–30 species. Other chemical constituents, like calcium, silica, iron, and sulphate are in varying extent of content in these cases. The chloride content seems to be even if it has retained a considerable amount; it will probably not be injurious to desmid-life when it is accompanied by or balanced with a content of calcium and other nutrient substances. Here the writer introduces the table of water analyses of the two cases of swamp, Naga-numa of Shimokita peninsula, lying on the Pacific coast, and the Hakuryu-ko lying inland, far away from the sea.

Name of swamp	pH	Consumption of $KMnO_4$	NH_4-N	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Naga-numa	6.5	12.64	0.01	7.92	23.47	0.005	4.8	5.8	7
Hakuryu-ko	5.4	28.76	0.03	7.49	23.46	0.005	8.4	11.5	98

The chloride is equal to the silica and iron contents in these two swamps, while the contents of calcium and sulphate, and the consumption of $KMnO_4$ in Naga-numa are about half the amount found in Hakuryu-ko. The swamps and ponds lie among dunes behind the sea coast, as at Ohtaki-numa and Hirataki-numa of the Tsugaru peninsula. Karasu-numa near Akita, Tanega-ike near Tottori, and Banryu-ko near Masuda contain an excess of chloride (about 20–54 mg per litre) while the contents of other chemical constituents (especially calcium) are relatively smaller. Thus the unbalanced contents of the substances seems to be unfavourable to desmid-life. In fact, the desmid-flora is poor in these swamps. Chloride content of over 50 mg per litre is conspicuously unfavourable for desmids, and is confined to those special species which are adapted to an extraordinary amount of chloride. Figure 4 shows the relation between the content of chloride and the species number.

5. The relation between iron content and the species number

The iron content varies in degrees in moor-bogs and swamps. It is divided into two groups concerning the content of iron in the moor-bogs; namely one is 0.005–0.05 mg per litre, and the other is 0.2–0.35 mg per litre. On the other hand, the two groups of iron content are not distinct in swamps; and swamps-waters, in general, contain 0.005–0.09 mg per litre. The maximum number of desmid-species are up to 120 in either case of both types. In *sphagnum*-moor bogs 60–70 species of desmids are equally found both where there is a small content of iron, and also in a large content of it. In swamps, about 70 or 80 species of desmids are usually found but they sometimes amount to 120 species under favourable conditions. So the writer compared both habitats: that is, the *sphagnum* bogs rich in desmids, and the swamps where over 70–80 species were found. The following table shows the relation of the other nutrient substances in the same content of iron (0.005 mg per litre)

Name of habitat	pH	Consumption of $KMnO_4$	NH_4-N	SiO_2	Cl	Fe	Ca	SO_4
Kotsutsumi-nishi-ike	4.9	26.54	0.01	1.71	6.25	0.004	1.0	2.8
Hakuryu-ko	5.4	28.76	0.03	7.49	23.46	0.005	8.4	11.5
Izu-numa	6.8	35.77	0.07	11.77	4.39	0.005	8.0	23.5
Tengunohara near Shirouma	4.8	40.45	0.05	0.86	0.84	0.005	0.4	1.6
Midagahara of Tateyama	4.6	37.29	0.09	1.28	1.35	0.005	0.8	4.0
Kakumanbuchi of Mt. Akagi	4.6	19.08	0.02	4.71	0.88	0.005	1.6	9.5

The chloride contents are in general larger in the swamps than in the moor-bogs, while the silica contents are not so distinct in chloride content in both waters of moor and swamp. The moor-waters brought in by springs or streams are at times more than 4 mg per litre in silica content, and this amount of silica content is at times somewhat greater than in swamp-water. The swamps are divided into two groups in calcium content: namely one is large (like Hakuryu-ko and Izu-numa) and the other is small (Kotsutsumi-nishi-ike) and almost equal to the content of the moor-water. The sulphate content of swamps is not definite in the same iron content, and varies in degrees. The swamps of Shinohara-ike and Umadame-ike are rich iron content; the silica content is slightly larger than in the amount of moor-water, and the chloride content is about twice as much as in the moor water; while the calcium content is either equal to the small amount found in Umadame-ike or 2–3 times as much as in the moor-water in Shinohara-ike. (See table 3)

Name of swamp	pH	Consumption of $KMnO_4$	NH_4-N	SiO_2	Cl	Fe	Ca	SO_4
Umadame-ike	5.0	17.7	0.005	4.71	4.17	0.3	0.8	2.2
Shinohara-ike	4.9	12.7	0.008	6.85	5.82	0.3	4.6	7.0

The iron content is not directly related to the variation of species-number. The writer did not meet with waters rich in iron content but poor in other nutrient substances, nor did he observe what Desmids appears in species-number. The swamp-waters are characteristic in richness of chloride content, compared with the moor-waters even if, in either case, the iron content is small or large. Figure 5 shows the relation between iron content and species-number.

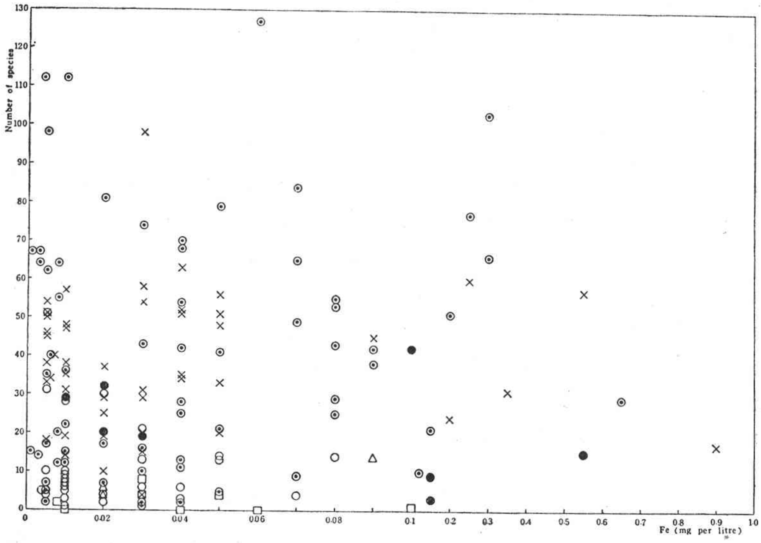


Figure 5. Relation between the iron content and the number of species.

6. The relation between silica content and the species-number

The silica contents are not more than 25 mg per litre, as shown on figure 6. The silica content of *sphagnum*-bogs is small (up to 2 mg per litre) and other contents than this amount should consider the presence of inflowing waters, due to springs or streams from the outside. The silica contents are

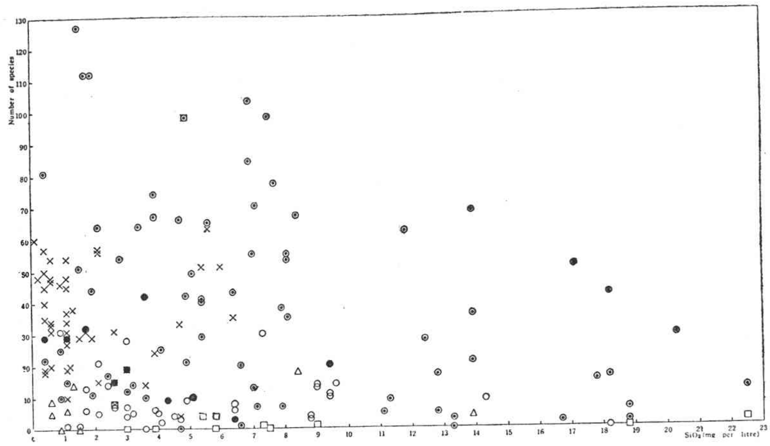


Figure 6. Relation between the silica content and the number of species.

not directly exerted to varying amounts as to the species-number of desmids; nor is the increase of silica content accompanied by a marked decrease of desmid-species. The silica content beyond 20 mg per litre is rare in the swamps or reservoirs, and it is impossible to examine the species number. In the swamps of Tomakomai, the silica content is 17 mg per litre, and is rich in desmids (51 species); in this swamp other chemical constituents are also present: 8.8 mg per litre in chloride, 7.2 mg in calcium, 83.3 mg in sulphate, and 0.005 mg per litre in iron. The writer has not met with special waters that have a large amount of silica content and a very small amount of other substances, so it was not possible to survey the species number of desmids. The writer compared the moor-bogs and swamps in the same silica content and the following table shows that some waters contained 0.4 mg per litre of silica content:

Name of swamp	pH	Consumption of $KMnO_4$	NH_4-N	Cl	SiO_2	Fe	Ca	SO_4	Number of species
Sanno-numa of Daisetsu	4.7	51.7	0.2	1.69	0.4	0.09	0.8	4.0	45
Gono-numa of Daisetsu	4.7	45.1	0.08	1.69	0.4	0.007	0.8	4.0	40
Shoro	4.9	36.6	0.1	7.94	0.4	0.02	1.6	1.6	81

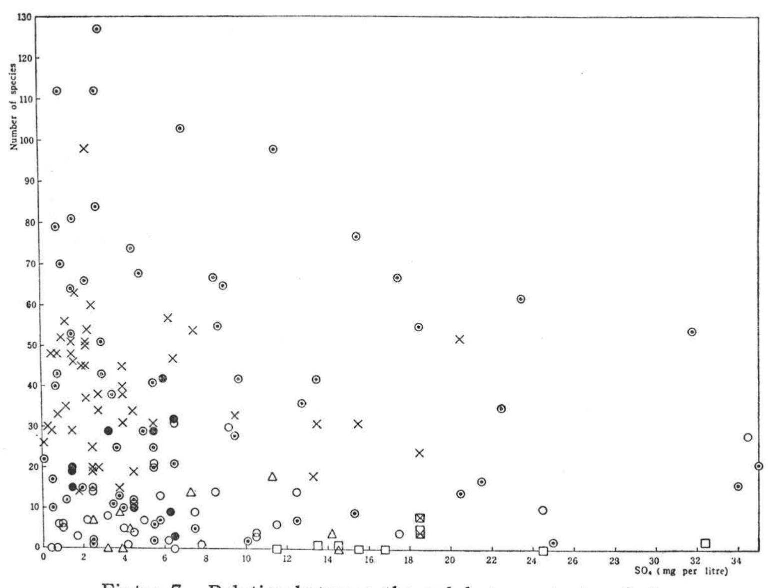
The chloride content in the Shoro swamp is about four times as much as in that of the Daisetsu moor, and the calcium content is about twice as much in the swamp, while the sulphate is rather small. Another instance is shown in the following table:

Name of swamp	pH	Consumption of $KMnO_4$	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Ohyachi (moor)	4.5	44.24	1.5	1.52	0.005	0.8	2.2	51
Fuse-ike	5.0	15.4	1.5	4.52	0.06	1.2	3.0	127

The chloride content in the swamp-water of Fuse-ike is about three times as much as that in the moor-waters of Ohyachi, and the calcium and the sulphate contents are about one and one-half times as much as the latter, while the organic matter is decreased to one-third the amount, and the desmids are twice as rich in the swamp-water. The above two cases show the necessity of a moderate amount of chloride and calcium to increase desmid-species, and that the content of iron and sulphate is not so important to the increase of species-number.

7. The relation between sulphate content and the species-number

The Desmids are rich in waters where there is a small content of sulphate:



Figtre 7. Relation between the sulphate content and the number of species.

0.5–10 mg per litre in content. (see Figure 7) The other chemical constituents seem to be related to many productions of desmids in the same content of sulphate, and the richer it is in other chemical constituents, the richer it is in Desmids. It is a favourable condition for desmids when the contents of calcium and chloride exist in definite ratio. The writer introduces some iustances of water analyses of various waters of the same sulphate content in the following table:

Name of swamp	pH	Consumption of $KMnO_4$	SiO_2	Cl	Fe	Ca	SO_4	Number of species
Ishigaki-ike	5.1	14.5	1.93	7.60	0.01	1.68	1.0	112
Ogata	5.4	30.08	7.06	11.82	0.04	2.4	1.0	70
Shijuhachi-ike	4.8	37.9	0.64	2.19	0.04	0.4	1.0	52
Kotsutsumi-nishi-ike	4.9	26.54	1.71	6.25	0.004	1.0	2.8	112
Moor-bog of Shirouma-ôike	5.0	18.33	12.84	1.18	0.01	0.4	2.8	38

While the waters which are unbalanced in content of calcium and chloride, those which are poor in chloride content to calcium do not produce many species of desmids. The following table shows this relation:

Name of swamp	pH	Consumption of $KMnO_4$	Cl	Ca	SO_4	Number of species
Tanega-ike	5.5	25.65	1.18	3.6	5.0	29
Sarugababa-ike	6.4	10.23	2.20	2.0	18.5	4
Oshideno-umi	5.5	25.28	2.87	8.01	36.0	21
Zuminoki-ike	5.5	17.46	2.20	8.82	34.5	16
Byodô-ike	6.5	24.44	3.85	4.01	21.5	17

There are some swamps rich in desmids where the sulphate content is fairly rich about 10–30 mg per litre. These swamps are generally poor in calcium but rich in chloride, and the chloride content is about twice as much or more. Waters which contained more than 50 mg per litre sulphate content, are very poor in desmids if other chemical constituents are uniformly poor in amount, but they are rich in desmids if they contain, uniformly, many other substances. The swamps of Tomakomai and Shiraoi-poroto-numa belong to this case and contain many species of desmids. In fact, the sulphate content is favourable to desmids in a small amount under the condition of a definite ratio in calcium and chloride content, namely if the ratio of calcium to chloride is about 1:2–5; if the relation is inverse, the waters are not rich in desmids. Furthermore the rich content of sulphate is similarly favourable to desmids under the same relations; but it is not favourable, but rather bad, if the sulphate is only in excess of other substances, or under the inverse relation of excess content of calcium to chloride.

8. Water temperature as a factor of distribution

The water temperatures show a parallel relation to the air temperature on regional specific conditions, and are below or above 2–3°C, compared with the air temperature; however the temperature of waters having inflowing streams or springs are markedly low, as shown in the following table:

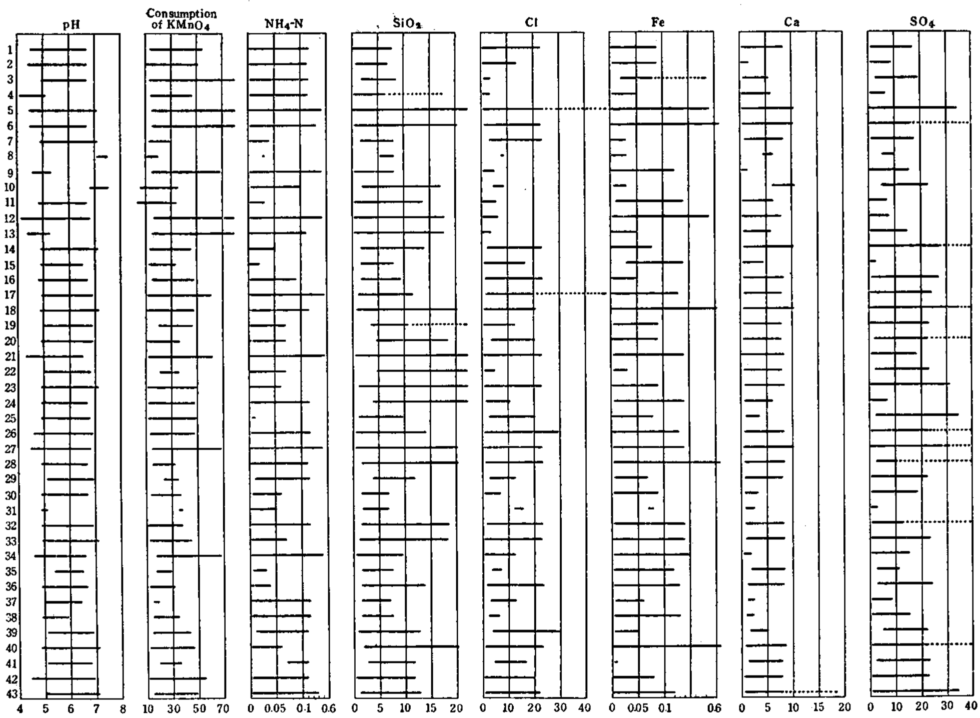
Name of swamp	Date of sampling	Air temperature	Water temperature	Weather	Note
Nenbutsu-ike of Togakushi	1958 15/VIII	24.0	12.0	fine	spring
Kagami-ike near Tsuta hot-spring	1958 28/VII	19.5	14.6	rain	inflowing stream
Tsuki-numa near Tsuta hot-spring	1958 28/VII	18.8	13.0	rain	inflowing stream

The water temperature in the summer season is about 20°C in the eastern part of Hokkaido, which is influenced by the cold current of Chishima; in other districts, like Tokachi far away from the sea or in the northern part of Hokkaido, the water temperature is 22-23°C on fine days. The water temperature of the reservoirs in the Tsugaru-plain, the northernmost part of Hondo, is about 27-28°C and more than 30°C in the shallow swamps among the dunes (as in Ohtaki, Kotsutsumi, and Bense-numa). These water temperatures already appear at the end of May in western Japan. The water temperature of the *sphagnum*-bog water in the afternoon of fine weather, is sometimes higher than 30°C in the subalpine regions of northern Japan. The water temperature is closely related to the metabolism in the water, however it has no direct exertion on desmid-life as a limiting factor. The temperature is exerted directly to circumstances, and promotes the formation of proper circumstances under regional climate, and then influences secondarily the growth of desmids. Consequently, the difference of water temperature produced by the difference of elevation of 500 metres, in view of vertical distribution of desmids, react highly on the land plant life, but not directly on the algae of the water-life. The desmid-flora of the moor-bogs near Shirouma-ôike does not differ from the flora of Kamino-tanbo which lies below 500 metres. The difference of the composition of desmid-flora is chiefly due to the difference of circumstances, especially to the difference of the dissolved substances. Consequently even if a change for distribution is given, the transported species are not settled in new circumstances when the nature of the circumstances is inadequate for the desmid. It is important that the temperatures are influenced by the circumstances of lakes, swamps, and other kinds of waters, and what circumstances are formed by the water temperature as a result.

The nature of the desmid-species in relation to the environmental factors

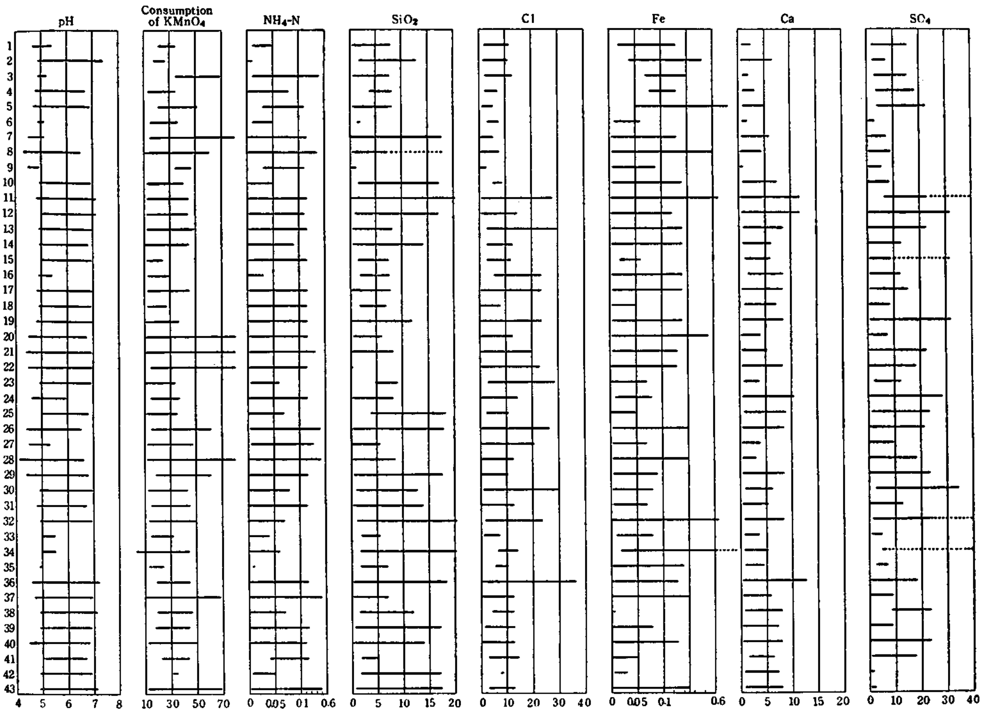
In the above chapter the writer dealt with the correlation between desmids and the analytical character of the waters as environmental factors, without any consideration of the species individuals. Now the writer deals with the individual nature of species to environmental conditions. The following tables 9-17 show the extent of the chemical constituents which permit desmid-life, and the dotted lines on the table show the probability of presence in each chemical constituent of the habitats, unless the writer has not yet found such in the range of chemical constituents.

Table 9. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



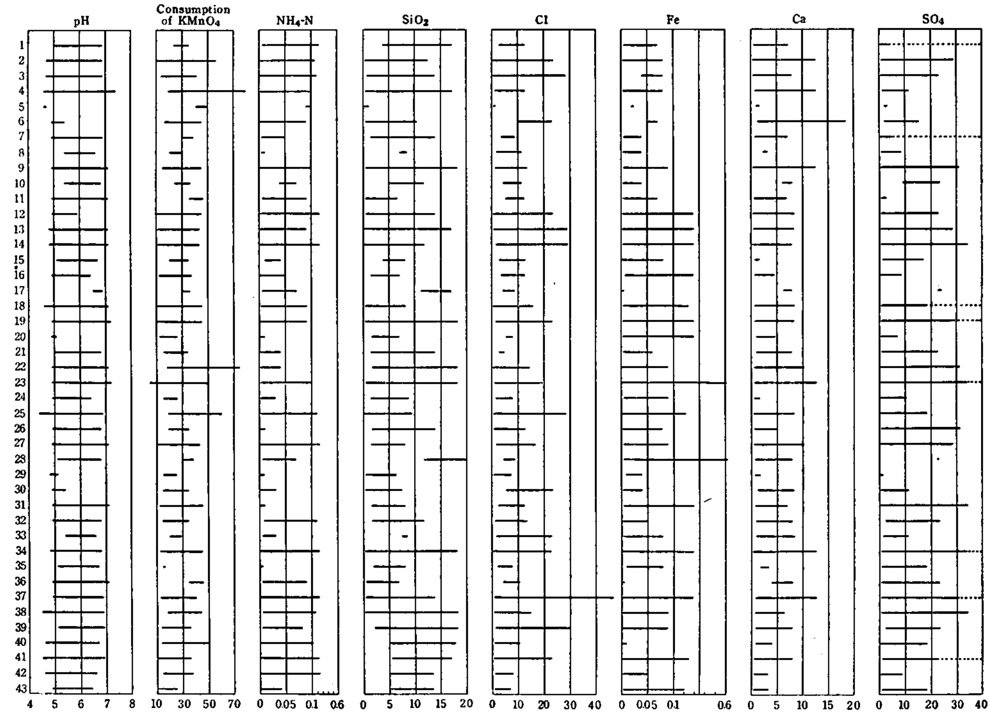
1. *Spirotaenia condensata*
2. *Cylindrocystis Brébissonii*
3. *Cyl.* .. var. *minor*
4. *Cyl. crassa*
5. *Netrium digitus*
6. *N.* .. var. *Nägelii*
7. *N.* .. var. *lamellosum*
8. *N.* .. var. *rectum*
9. *N. oblongum*
10. *Gonatozygon monotaenium*
11. *G. aculeatum*
12. *Penium polymorphum*
13. *P. silvae-nigrae*
14. *P. margaritaceum*
15. *P. cylindrus*
16. *P. spirostriolatum*
17. *Closterium cynthia* var. *Jenneri*
18. *Cl. dianae*
19. *Cl. Ehrenbergii*
20. *Cl. gracile*
21. *Cl. intermedium*
22. *Cl. lanceolatum*
23. *Cl. moniliferum*
24. *Cl. lineatum*
25. *Cl. libellula*
26. *Cl.* .. var. *intermedium*
27. *Cl. littorale*
28. *Cl. Lunula*
29. *Cl. macilentum*
30. *Cl. parvulum*
31. *Cl. rostratum*
32. *Cl. setaceum*
33. *Cl. toxon*
34. *Cl. ulna*
35. *Cl. calosporum*
36. *Cl. navicula*
37. *Cl. idiosporum*
38. *Cl. Ralfsii* var. *hybridum*
39. *Cl. abruptum*
40. *Cl. Kützingii*
41. *Cl. praelongum*
42. *Cl. striolatum*
43. *Cl. venus* var. *incurvum*

Table 10. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



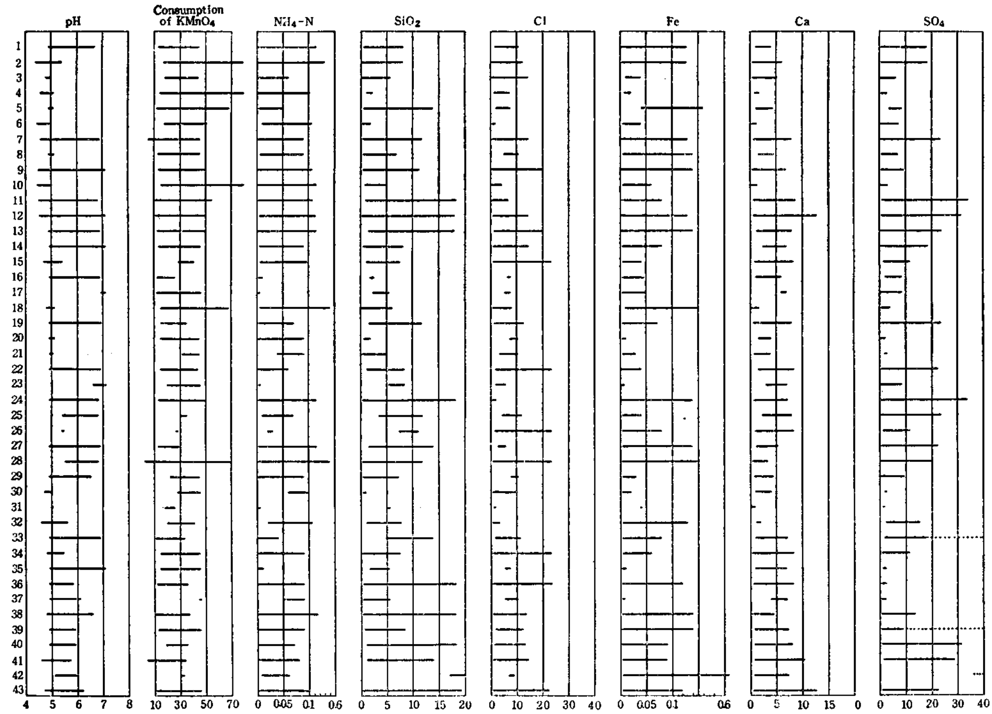
1. *Cl. costatum* var. *Westii*
2. *Cl. acerosum*
3. *Cl. Baillyanum*
4. *Cl. nematodes*
5. *Cl strigosum*
6. *Spin oclosterium curvatum*
7. *Doc idium undulatum*
8. *Ple urotaenium minutum*
9. *Pl.* .. var. *crassum*
10. *Pl.* .. var. *gracile*
11. *Pl. Trabecula*
12. *Pl.* .. var. *rectum*
13. *Pl. Ehrenbergii*
14. *Pl. excelsum*
15. *Pl. subcoronulatum*
16. *Pl. verrucosum*
17. *Pl. nodosum*
18. *Pl. kayei*
19. *Triploceras gracile*
20. *Tetmemorus Brébissonii* var. *minor*
21. *T. laevis*
22. *T. granulatus*
23. *Cosmarium oblongum*
24. *C. cucurbitinum*
25. *C. Clevei*
26. *C. cucurbita*
27. *C. parvulum*
28. *C. globosum*
29. *C.* .. f. *minor*
30. *C. curtum*
31. *C. subturgidum* f. *minor*
32. *C. australe*
33. *C. alpestre*
34. *C. turgidum*
35. *C.* .. var. *ovatum*
36. *C. connatum*
37. *C. moniliforme*
38. *C.* .. f. *pandriforme*
39. *C. zonatum*
40. *C. amoenum*
41. *C. pseudamoenum*
42. *C. elegantissimum*
43. *C. contractum*

Table 11. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



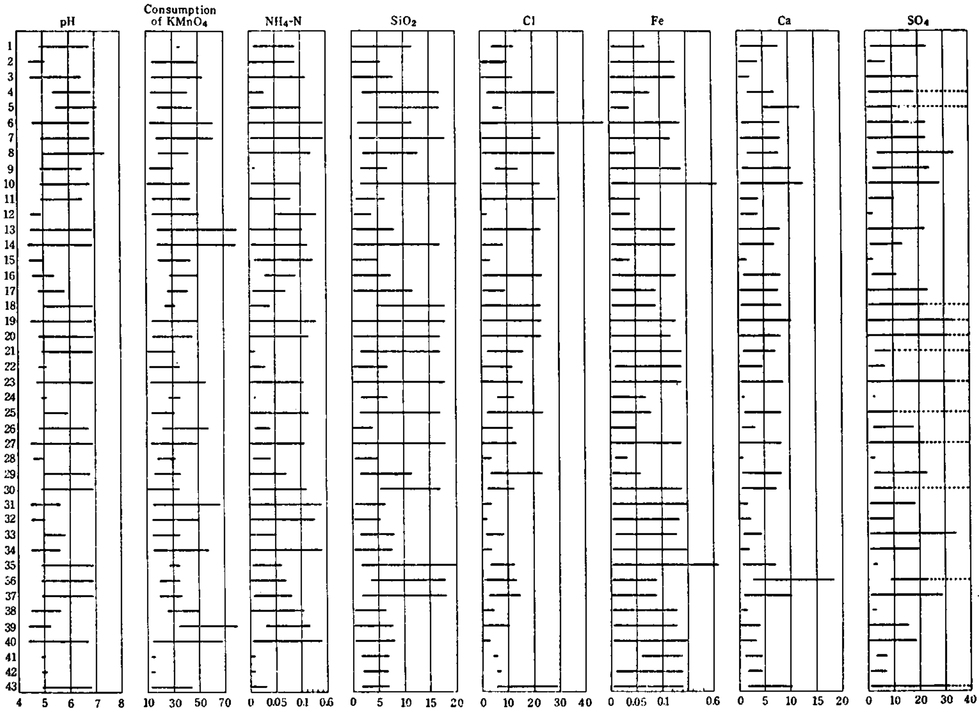
1. *C. contractum* f. *Jacobsenii*
2. *C.* .. var. *ellipsoideum*
3. *C.* .. var. *minutum*
4. *C. inconspicuum*
5. *C. asbhaerosporum* var. *strigosum*
6. *C. bioculatum*
7. *C. tinctum*
8. *C.* .. var. *intermedium*
9. *C. depressum*
10. *C. phaseolus* var. *minor*
11. *C. pseudoprotuberans* var. *alpinum*
12. *C. nipponicum*
13. *C. obsoletum*
14. *C.* .. var. *sitvense*
15. *C. maximum* var. *minor*
16. *C. dorsitruncatum*
17. *C. circulare*
18. *C. pachydermum*
19. *C. ocellatum*
20. *C. taxichondriforme*
21. *C. taxichondrum* var. *decachondrum*
22. *C. undulatum* var. *crenulatum*
23. *C. obtusatum*
24. *C. maculatum*
25. *C. subcucumis*
26. *C. Lundellii* var. *circulare*
27. *C.* .. var. *ellipticum*
28. *C.* .. var. *corruptum*
29. *C. urceum*
30. *C. pokornyanum*
31. *C. succisum*
32. *C.* .. var. *hyalinum*
33. *C. hammeri*
34. *C.* .. var. *protuberans*
35. *C. Nymannianum*
36. *C. quadratulum*
37. *C. granatum*
38. *C. trilobulatum*
39. *C. galeritum* var. *minus*
40. *C. subtumidum*
41. *C. pseudopyramidatum*
42. *C.* .. var. *carniolicum*
43. *C. pseudonitidulum* var. *validum*

Table 12. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



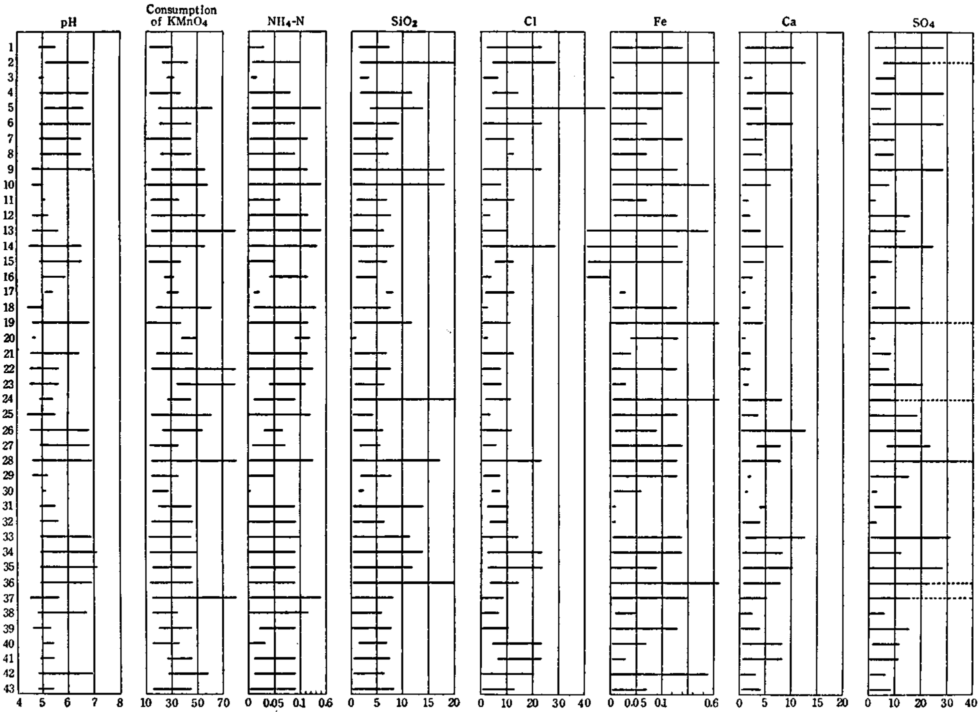
1. C. *pyramidatum*
2. C. *venustum* f. *minor*
3. C. *raeticum*
4. C. *subortogonum*
5. C. *norimbergense*
6. C. *decedens*
7. C. *quadratum*
8. C. *pseudobinerve*
9. C. *exiguum*
10. C· *pseudoexiguum*
11. C. *minimum*
12. C. *angulosum*
13. C. .. var. *concinnum*
14. C. *Regnesi*
15. C. *cymatonotophorum*
16. C. *adoxum*
17. C. *pygmaeum*
18. C. *prominulum* var. *subundulatum*
19. C. *sexangulare* f. *minima*
20. C. *abbreviatum* f. *minor*
21. C. *clepsydra*
22. C. *regnellii* f. *ninima*
23. C. *Meneghinii*
24. C. *impressulum*
25. C. *bengalicum*
26. C. *laeve*
27. C. .. var. *septentrionale*
28. C. *quadrifarium* f. *hexasticha*
29. C. *monomazum* var. *amazum*
30. C. *caelatum*
31. C. .. var. *spectabile*
32. C. *nasutum*
33. C. *portianum*
34. C. .. var. *nephroideum*
35. C. *sphalerostichum*
36. C. *geminatum*
37. C. *reniforme*
38. C. .. var. *elevatum*
39. C. *ornatum*
40. C. *polonicum*
41. C. *sikhimense*
42. C. *Raciborskii*
43. C. *punctulatum*

Table 13. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



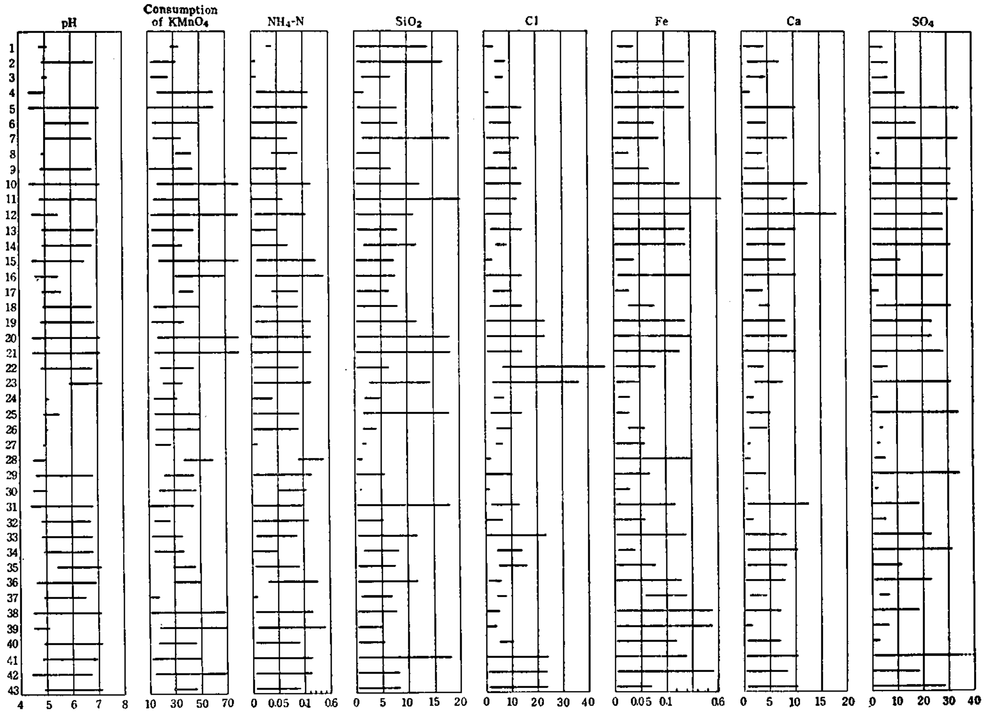
1. *C. punctulatum* var. *subpunctulatum*
2. *C. vogesiacum*
3. *C. quinarium*
4. *C. tetraophthalmum*
5. *C. ochthodes*
6. *C. margaritiferum*
7. *C. Blyttii*
8. *C. subprotumidum* var. *gregorii*
9. *C. malinvernianum*
10. *C. binum*
11. *C. pseudobroomei*
12. *C. obliquum* f. *tatrica*
13. *Arthrodesmus incus*
14. *A.* .. f. *minor*
15. *A. quiriferus* var. *brevispinis*
16. *A. phimus*
17. *A. triangularis*
18. *A.* .. var. *latiuscula*
19. *A. extensus*
20. *A. convergens*
21. *A. curvatus*
22. *A. subulatus*
23. *A. octocornis*
24. *Xanthidium hastiferum* var. *curvispinosum*
25. *X. cristatum* var. *uncinatum*
26. *X.* .. var. *leiodermum*
27. *X. antilopaeum*
28. *X.* .. var. *laeve*
29. *X. fasciculatum*
30. *X. acanthophorum*
31. *X. armatum*
32. *Euastrum insulare*
33. *E. Lütkemülleri* var. *carniolicum*
34. *E. montanum*
35. *E. binale*
36. *E.* .. var. *Koreanum*
37. *E.* .. var. *sectum*
38. *E.* .. var. *hians*
39. *E.* .. var. *minus*
40. *E. sublobatum*
41. *E.* .. var. *Kriegeri*
42. *E. exile*
43. *E. platycerum*

Table 14. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



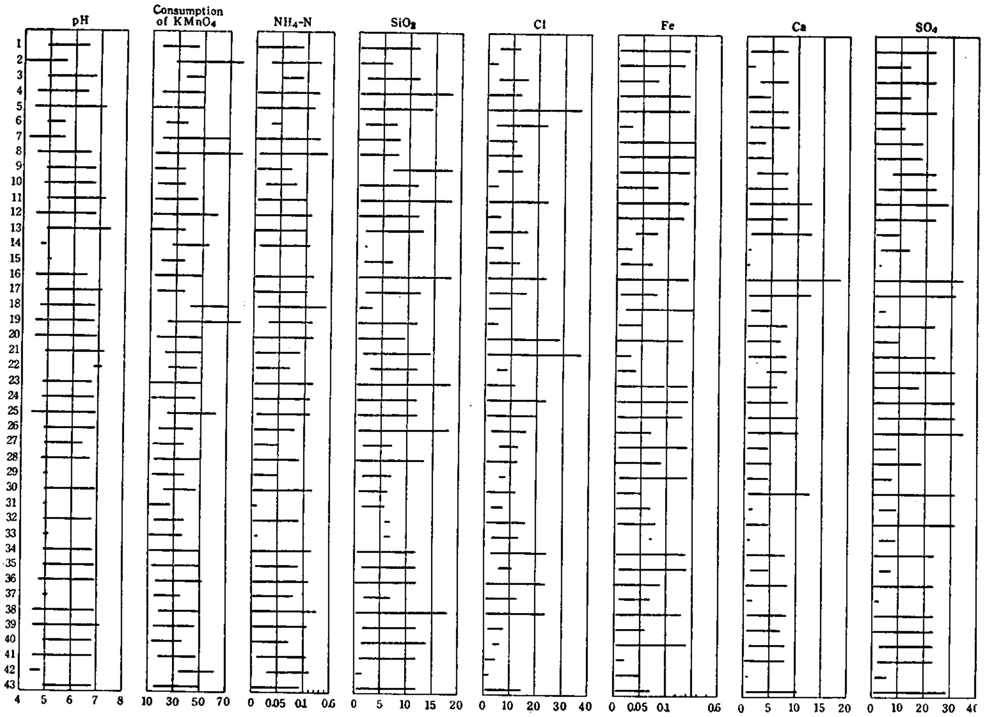
1. *E. turgidum*
2. *E. germanicum*
3. *E. spinulosum*
4. *E.* .. var. *inermius*
5. *E. gemmatum*
6. *E. verrucosum*
7. *E. ansatum*
8. *E.* .. var. *dideltiforme*
9. *E.* .. var. *pyxidatum*
10. *E. cuneatum*
11. *E. indicum* var. *capitatum*
12. *E. ampullaceum*
13. *E. didelta*
14. *E. gnathophorum*
15. *E. sinuosum* var. *dideltoides*
16. *E.* .. var. *subjenneri*
17. *E.* .. var. *parallelum*
18. *E.* .. var. *gangense*
19. *E.* .. var. *scrobiculatum*
20. *E.* .. var. *aboense*
21. *E.* .. var. *reductum*
22. *E. crassum*
23. *E. pinnatum*
24. *E. oblongum*
25. *E. humerosum*
26. *E. divaricatum*
27. *E. elegans* var. *pseudelegans*
28. *E. denticulatum*
29. *E. dubium*
30. *E.* .. var. *tritum*
31. *E. praemorsum*
32. *E. bidentatum*
33. *E. Turneri*
34. *Micrasterias pinnatifida*
35. *M. decemdentata*
36. *M. crux-melitensis*
37. *M. truncata*
38. *M. denticulata* var. *angulosa*
39. *M.* .. var. *angusto-sinuata*
40. *M.* .. var. *notata*
41. *M. Thomasiana*
42. *M. rotata*
43. *M. sol* var. *ornata*

Table 15. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



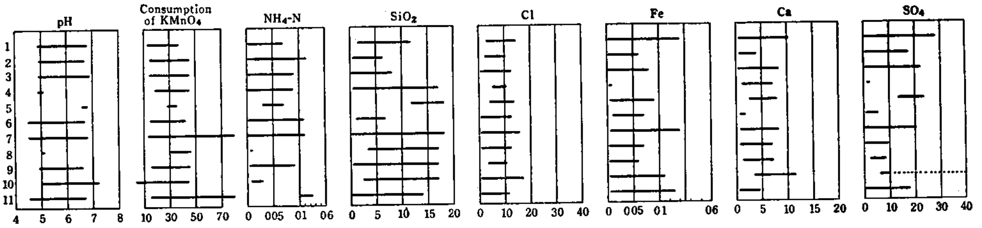
1. *M. apiculata*
2. *M. foliacea*
3. *M. alata*
4. *Staurastrum pileolatum*
5. *St. muticum*
6. *St. coarctatum*
7. *St.* .. var. *subcurtum*
8. *St. insigne*
9. *St. pachyrhynchum*
10. *St. orbiculare* var. *depressum*
11. *St. lapponicum*
12. *St. alternans*
13. *St. dilatatum*
14. *St. disputatum* var. *sinense*
15. *St. dispar*
16. *St. punctulatum*
17. *St. varians* f. *truncata*
18. *St. Dickiei*
19. *St.* .. var. *circulare*
20. *St. apiculatum*
21. *St. dejectum*
22. *St.* .. var. *patens*
23. *St. connatum*
24. *St.* .. var. *pseudamericanum*
25. *St. leptodermum* f. *minor*
26. *St. megacanthum*
27. *St.* .. var. *scoticum*
28. *St. wandae* var. *brevispinum*
29. *St. glabrum*
30. *St. O'Mearii*
31. *St. cuspidatum*
32. *St. longispinum* var. *bidentatum*
33. *St. bifidum*
34. *St. quadrangulare*
35. *St. lunatum*
36. *St. avicula*
37. *St. subcruciatum*
38. *St. Hystrix*
39. *St. Simonyi*
40. *St. cristatum*
41. *St. teliferum*
42. *St. hirsutum*
43. *St. erasum*

Table 16. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



1. *St. oxyrhynchum*
2. *St. scabrum*
3. *St. monticulosum* var. *bidens*
4. *St. furcatum*
5. *St. senarium*
6. *St. forficulatum* var. *verrucosum*
7. *St. inconspicuum*
8. *St brachiatum*
9. *St. bacillare* var. *obesum*
10. *St. polymorphum*
11. *St. asteroideum* var. *nanum*
12. *St. margaritaceum*
13. *St. crenulatum*
14. *St. proboscideum*
15. *St. cyrtocerum*
16. *St. tetracerum*
17. *St. excavatum*
18. *St. inflexum*
19. *St. micron*
20. *St. paradoxum* var. *parvum*
21. *St. gracile*
22. *St. elegantissimum*
23. *St. arachyne*
24. *St. duacense*
25. *St. sexcostatum* var. *productum*
26. *Si. manfeltii* var. *annulatum*
27. *St. cerastes*
28. *St. vestitum*
29. *St. saltans*
30. *St. leptocladum*
31. *St. tohopekaligense*
32. *St. hantzii* var. *japonicum*
33. *St. leptacanthum*
34. *St. sexangulare* var. *subglabrum*
35. *St. arctiscon*
36. *Hyalotheca dissiliens*
37. *H.* .. var. *minor*
38. *H.* .. var. *tatrica*
39. *H. mucosa*
40. *Spondylosium moniliforme*
41. *Sp. planum*
42. *Sp. pulchellum*
43. *Desmidium aptogonum*

Table 17. Desmid species showing the range of growing condition to the chemical nature of inland waters of Japan



1. *D. Baileyi*
2. *D. coarctatum*
3. *D. Swartzii*
4. *D. pseudostreptonema*
5. *Sphaerozosma aubertianum*
6. *S. excavatum*
7. *S. granulatus*
8. *S. vertebratum* var. *latius*
9. *Onychonema filiformis*
10. *O. laeve*
11. *Gymnozyga moniliformis*

Historical sketch on the Research of Japanese Desmids

The first scientific account on Japanese Desmids appeared in 1870 in "Algae Japonicae," by W.F.R. SURRINGER. He described one species, *Closterium Japonicum* SURR. J. ROY & BISSET has published a paper, "Notes on Japanese Desmids," in the Journal of Botany, vol. 24, in 1886. The material for this research was collected at Yokohama, and at Junsai-numa near Hakodate; they reported 129 species, one subspecies, and 6 varieties of Japanese Desmids. They are the following:

Micrasterias denticulata, M. rotata, M. crux-melitensis, M. apiculata, M. decemdentata, M. pinnatifida, Euastrum verrucosum, E. orbiculare, E. spinulosum subsp. *africanum,* subsp. *inermius, E. oblongum, E. ansatum, E. elegans, E. sibiricum, *Cosmarium orthopleurum, C. conspersum, C. latum, C. margaritatum, C. Kjellmani* var. *ornatum, C. Botrytis, *C. fusum, C. tetraophthalmum, C. punctulatum, C. geminatum, C. Boeckii, C. Regnesi, C. pulcherrimum, C. crenatum, C. striatum, *C. sexangulare* var. *minor, *C. retusum* var. *laeve, *C. capitatum, C. impressulum, C. Hammeri* var. *subangustatum, C. Clepsydra, C. phaseolus,* var. *achondrum, C. galeritum* var. *minus, C. obsoletum, C. depressum, *C. decachondrum, C. pachydermum, C. pseudopyramidatum* var. *stenonotum, C. pygmaeum, C. Meneghinii, C. moniliforme, C. connatum, C. excavatum, C. Portianum, C. turgidum, C. striolatum, Arthrodesmus convergens, A. bifidus, A. octocornis, Staurastrum Bieneanum, St. orbiculare* var. *elevatum,* var. *depressum, *St. globosum, St. corniculatum, St. leptodermum, St. brevispinum* var. *minus, *St. pseudocuspidatum, St. dejectum* var. *apiculatum, St. connatum,* *var. *rectangulum, St. Dickiei,* var. *granulatum, *St. oxyrhynchum, St. cuspidatum, St. avicula, St. arcuatum, St. tunguscanum, St. bifidum, St. brachiatum, St. dilatatum, St. tricorne, St. teliferum, *St. subteliferum, St. cristatum, St. quadrangulare, St. monticulosum, *St. submonticulosum, St. spinosum, St. margaritaceum,* var. *hirtum, St. polymorphum, St. crenulatum, St. aculeatum, St. vestitum, St. gracile, St. paradoxum, St. tetracerum, St. Arachne, St. leptocladum* var. *cornutum, St. inflexum, St. subarmigerum, *St. sexangulare* var. *laeve, *St. Hantzii* var. *japonicum, *St. quadricornutum, Xanthidium fasciculatum, X. antilopaeum, *X. leiodermum, Closterium striolatum, Cl. Lunula, Cl. acerosum, *Cl. turgidum* var. *curtum, Cl. lineatum, Cl. macilentum, Cl. Ehrenbergii, Cl. moniliferum, Cl. dianae, Cl. Leibleinii, Cl. venus, Cl. pronum, Cl. linea, Penium digitus, *Docidium baculoides, D. Trabecula* var. *crassum, D. maximum* var, *subclavatum, D. indicum, D. crenulatum, Spirotaenia condensata. Onychonema laeve* var. *micracanthum, O. filiformis, Sphaerozosma excavatum, *Sph. granulatum, Desmidium Swartzii, D. Baileyi, D. aptogonum.*

Of these species, *Penium digitus* should be called *Netrium digitus*; the species of *Docidium* are all called *Pleurotaenium*; 21 species, new to this science, indicated by an asterisk.

M. HIGASHI enumerated all of the Japanese Desmids at that time, together with his own discovered species, under his, "List of Japanese Freshwater Algae," in OKAMURA's Nippon Sorui Meii, published in 1916. This enumeration includes the species found by SURRINGER, ROY & BISSET, and some species recorded by Japanese botanists: for instance, N. OHNO, M. HIGASHI. The new addition to the Japanese Desmids are the following 31 species:

Mesotaenium Endlicherianum, Spirotaenia obscura, Netrium oblongum var. *cylindricum, Gonatozygon monotaenium, G. pilosum, Pleurotaenium, coronatum* var. *nodulosum, Pl. Ehrenbergii, Pl. nodo-*

sum, Pl. Kayei, Pl. gracile f. *aculeatum. Docidium undulatum, Cosmarium pseudoconnatum, C. foveatum, Arthrodesmus triangularis, Xanthidium armatum, Staurastrum tohopekaligense, St. echinatum, St. sexangulare* var. *intermedium, Tetmemorus Brébissonii* var. *attenuatus, T. minutus, Micrasterias truncata, M. papillifera, M. sol* var. *ornata, M. mahabuleshwarensis* var. *wallichii, M. alata* var. *depressa, M. radians* var. *typica, Spondylosium papillatum, Desmidium aptogonum* var. *acutius, D. coarctatum, Bambusina moniliformis, Hyalotheca dissiliens.*

H. TAKEDA published his "alpine plants" in 1917 and in this book he has created an interest in the exploration of alpine Desmids, and has figured some species of Desmids as follows:

Cosmarium retusum, Arthrodesmus incus, Xanthidium armatum, Staurastrum leptocanthum, St. hystrix, St. sexangulare.

He also introduced some Desmids in his paper, "Kirigamine, Kamaga-ike and Yashimaga-ike," in the Journal of Japanese Alpine Club, vol, 11, published in 1917, and mentioned the following 8 species:

Xanthidium fasciculatum, Staurastrum sexangulare var. *intermedium, Cosmarium nasutum, C. amoenum, Euastrum ventricosum, E. ampullaceum, E. ansatum, Micrasterias truncata.*

This introduction is a second contribution to HIGASHI's list. The *sphagnum*-moor bogs of Mt. Kirigamine were particularly noted by many phycologists, and the Desmids of these moor-bogs are reported and illustrated in the papers of D. USHIYAMA, who figured 21 species from "Yashima-ike," in his "Rotifers in Lake Suwa and Desmids in Yashima-ike," in Hakubutsugakukaishi, vol. 21, no. 30, in 1923; and R. FUJISAWA has added the following species to the Desmid list of Yashima-ike in his paper, "Desmidiaceae in Ina-district and Yashima-ike of Shinano province," in Journal of Japanese Botany vol. 10, 1934.

Netrium oblongum var. *cylindricum, N. digitus* var. *rhomboideum?, Penium minutum, P. libellula* var. *interruptum, Closterium didymotocum, Cl. cornu, Docidium undulatum* f. *perundulata, Pleurotaenium nodosum, Pl. trabecula* var. *rectum, Euastrum humerosum* f. *scrobiculata, Micrasterias truncata* f. *granulata, Cosmarium depressum, C. Hammeri* var. *protuberans, C. palangula, C. pseudopyramidatum, C. quadrifarium, C. subcucumis, Staurastrum cyrtocerum,* var. *compactum, St. dilatatum, Desmidium swartzii, Hyalotheca dissiliens* var. *tatrica, Tetmemorus laevis, T. granulatus* var. *attenuatum, Mesotaenium Degreyi*

R. FUJISAWA has further summarized the Japanese species of *Micrasterias*, known up to that time, in his paper on Hakubutsugaku-zatshi, no. 58, published in 1936. The Japanese *Micrasterias* have in all 17 species, 5 varieties, and one form.

T. KAWAMURA has published his „Freshwater Biology," vol. 1, in 1918, and in this book he figured many species which were collected by himself in various parts of Japan, but some of which are not named yet.

Y. OKADA has recorded 45 species as a new addition to the Japanese flora in his paper, "Notes on Japanese Desmid, with special reference to the newly found species I–IV," in the Botanical Magazine, vol. 50, 1936.

Y. OKADA has illustrated many Desmids from the Japan islands in ASAHINA's Inkwa Shokubutsu Dukan, published in 1939. These illustrations included many species from the Kurile Islands, and from Kôtôsho, near Formosa; but species of the main islands are not as yet known.

M. UÉNO and NEGORO, K. have noticed some desmids from the *sphagnum* bog waters of Usagishima in Nikko-Yumoto, respectively, in 1931 and 1938. These contributions to the Desmids of Japan were made before the writer began his research studies of desmids.

Recently, in 1956, Y. OKADA has proposed a new classification of Desmids into 5 families, based on the mode of conjugation, and the position of zygospore formation.

Floristic relationships between Japan Proper and neighbouring regions

Japanese Desmids hitherto known in Japan Proper are in number 572 species, 256 varieties, and 38 forms. Of these 377 species, 205 varieties, and 27 forms are now newly known to Japan. Of these species, the varieties ane forms newly recorded in the Asiatic zone number 130 species, 87 varieties, and 13 forms. Their details are shown in the following table:

Genus	Number of species known in Japan	Number of species new to Japan	Number of species new to Asia	Number of varieties known in Japan	Number of varieties new to Japan	Number of varieties new to Asia	Number of forms known in Japan	Number of forms new to Japan	Number of forms new to Asia
Gonatozygon	4	2	1	1	1	1	0	0	0
Spirotaenia	2	0	0	0	0	0	0	0	0
Mesotaenium	3	2	0	3	3	3	0	0	0
Cylindrocystis	2	1	0	2	2	1	0	0	0
Netrium	3	2	1	5	3	0	0	0	0
Penium	8	6	1	2	2	2	0	0	0
Roya	1	1	1	0	0	0	0	0	0
Closterium	50	29	5	21	15	8	0	0	0
Spinoclosterium	1	1	0	0	0	0	0	0	0
Docidium	2	1	0	0	0	0	0	0	0
Pleurotaenium	22	9	1	15	9	3	0	0	0
Ichthyocercus	1	1	0	0	0	0	0	0	0
Triploceras	1	0	0	0	0	0	0	0	0
Tetmemorus	3	1	0	2	2	0	0	0	0
Cosmarium	194	149	57	81	68	27	30	21	10
Arthrodesmus	16	13	7	11	11	5	2	2	0
Xanthidium	14	7	2	6	4	1	0	0	0
Euastrum	47	25	5	25	21	5	1	1	0
Micrasterias	17	5	1	8	4	1	0	0	0
Staurastrum	160	115	46	68	56	28	5	3	3
Cosmocladium	2	0	0	0	0	0	0	0	0
Spondylosium	3	2	1	0	0	0	0	0	0
Hyalotheca	4	2	0	2	1	1	0	0	0
Gymnozyga	1	0	0	1	1	0	0	0	0
Desmidium	5	1	0	0	0	0	0	0	0
Sphaerozosma	4	2	1	3	2	1	0	0	0
Onychonema	2	0	0	0	0	0	0	0	0
Total	572	377	130	256	205	87	38	27	13

The species newly discovered to science are 19 species and 38 varieties which are as follows:

Pleurotaenium elatum var. *subundulatum*, *Pl. annulare* var. *zonatum*, *Pl. simplicissimum* var. *semiundatum*, *Euastrum excavatum*, *E. glaberrimum*, *E. acanthophorum* var. *bigranulatum*, *E. binale* var. *parallelum*, *E. didelta* var. *japonicum*, *E. crassicole* var. *incisum*, *Arthrodesmus rhomboides*, *A. triangularis* var. *minor*, var. *acuminatum*, *A. trispinatus* var. *japonicum*, *A. extensus* var. *retusum*, *Xanthidium concinnum* var. *ozense*, *X. japonicum*, *Cosmarium divergentiforme*, *C. synthlibomenum* var. *montanum*, *C. taxichondrum* var. *magnum*, *C. subcucumis* var. *elongatum*, *C. variolatum* var. *foraminum*, *C. subtumidum* var. *rotundum*, *C. paulense* var. *japonicum*, *C. pseudarctoum* var. *colorum*, *C. yesoensis*, *C. impressulum* var. *octangularis*, *C. amoenum* var. *alternans*, *C. lapponicum* var. *granulatum*, *C. crispatum*, *C. fuseense*, *C. margispinatum*, *Staurastrum asoensis*, *St. cristatum* var. *japonicum*, *St. Dickiei* var. *latum*, *St. Biwaensis*, *St. longistipes*, var. *nodulosum*, *St. leptodermum* var. *biwaense*, *St. subaciculiferum*, *St. orbiculare* var. *Messikommeri*, *St. aculeatum* var. *japonicum*, *St. Koidzumii*, *St. micron* var. *unidentatum*, *St. dentatum* var. *gracilis*, *St. zonatum* var. *emarginatum*, *St. subheteroplophorum* var. *minor*, *St. iotanum* var. *longatus*, *St. pseudoexcavatum*, var. *binodulum*, *St. biannuliferum*, *St. subdisparatum*, *St. pentacrinum* var. *trisetum*, *St. karasuensis*, *St. subtilissimum*, *St. cingulum* var. *inflatum*, *St. asterias* var. *divergens*.

The northern element of Desmids show 29 species and 3 varieties which are the following:

Mesotaenium macrococcum, *M. Degreyi* var. *Borgei*, *Cosmarium nasutum*, *C. anceps*, *Cosmarium perincisum*, *C. microsphinctum*, *C. decedens*, *C. cyclicum*, var. *arcticum*, *C. obilquum* f. *tatrica*, *C. phaseolus* f. *minor*, *C. caelatum* var. *spectabile*, *C. Botrytis* var. *subtumidum*, *C. petsamoense*, f. *simplicius*, *C. notabile* var. *arcticum*, *C. asphaerosporum* var. *strigosum*, *C. geometricum* var. *suecicum*, *C. quadratum* f. *Willei*, *C. Ralfsii* var. *montanum*, *C. novae-semliae* var. *sibericum*, *C. crenatum* var. *bicrenatum*, *C. pulcherrimum* var. *boreale*, *Arthrodesmus crassus*, *Euastrum pinnatum*, *E. montanum*, *Staurastrum Clepsydra*, var. *sibericum*, *St. mutilatum*, *St. aculeatum* var. *ornatum*, *St. insigne*, *St. pileolatum*.

Among the southern elements of Desmids hitherto known in tropical Asia are the following: 80 species and one variety now clearly established in their distribution in Japan.

Closterium Wallichii, Cl. nematodes, Pleurotaenium indicum, Pl. subcoronulatum, Pl. elatum, Pl. mamillatum, Pl. trochiscum, Pl. verrucosum, Pl. ovatum, Pl. Kayei, Cosmarium australe, C. subturgidum f. *minor, C. moniliforme* f. *elliptica, C. striolatum* var. *Nordstedtii, C. obsoletum* var. *sitvense, C. auriculatum, C. Lundellii* var. *circulare, C. tithophorum* var. *depressum, C. maculatum, C. javanicum, C. pandriforme, C. aversum, C. urceum, C. subtumidum* f. *minor, C. sublatere-undatum, C. venustum* var. *brevius, C. rectangulare* var. *africanum, C. bengalense, C. dichondrum,* var. *subhexagonum, C. trachypleurum* var. *Nordstedtii, C. otus, C. armatum, C. binodulum, Arthrodesmus phimus, A. extensus* var. *malaccensis, A. convergens* f. *curta, A. curvatus, Xanthidium apiculatum, X. bengalicum, X. hastiferum* var. *javanicum, X. angulatum, Euastrum exile, E. sublobatum* var. *obtusatum, E. turgidum, E. dubium* var. *tritum, E. simplicius, E. flammeum, E. sinuosum* var. *subjenneri, E. indicum* var. *capitatum, E. gnathophorum, E. ansatum* var. *javanicum, E. ceylanicum, E. praemorsum, Micrasterias alata, M. lux, M. Thomasiana* var. *javanicum, M. foliacea, Staurastrum subsaltans, St. saltans, St. leptocladum, St. Zahlbruckneri, St. unguiferum, St. dejectum* var. *triangulatum, St. curvatum* f. *biradiata, St. ensiferum, St. pseudobiretum, St. ceylanicum, St. gyratum, St. columbetoides, St. acestrophorum, St. zonatum* var. *ceylanicum, St. asterias, St. gracile* var. *ornatum, St. tauphorum* var. *sumatranum, St. triforcipatum, St. limneticum* var. *Burmense, St. acanthastrum, St. submanfeldtii, St. galeatum, St. javanicum.*

The following species are representative of the cosmopolitan species found in Japan:

Netrium digitus, var. *lamellosum, Penium margaritaceum, Closterium libellula, Cl. gracile, Cl. cornu, Cl. lanceolatum, Cl. Kützingii, Cl. Ralfsii* var. *hybridum, Cl. parvulum, Cl. dianae, Cl. moniliferum, Cl. Leibleinii, Cl. juncidum, Cl. striolatum, Cl. Archerianum, Cl. Cynthia, Tetmemorus Brébissonii, Cosmarium moniliforme, C. pachydermum, C. contractum, C. granatum, C. Meneghinii, C. impressulum, C. laeve, C. Portianum, C. Botrytis, C. punctulatum, C. Blyttii, C. subspeciosum* var. *validius, Arthrodesmus convergens, Staurastrum punctulatum, St. dejectum, St. polymorphum, St. tetracerum, St. gracile, St. paradoxum, Hyalotheca dissiliens, Desmidium Swartzii, Sphaerozosma excavatum, Gymnozyga moniliformis.*

Some of the species hitherto known only in North and South America were also newly set up in their distribution in our country. They are the following 19 species:

Closterium Johnsonii, Cl. lineatum var. *costatum, Pleurotaenium minutum* var. *cylindricum, Cosmarium maximum, C. subquadrans, C. reniforme* var. *elevatum, C. formosulum* var. *mesochondrum, C. pseudopyramidatum* var. *stenonotum* f. *minor, Arthrodesmus subulatus* var. *Nordstedtii, Euastrum sinuosum* var. *parallelum, Staurastrum trihedrale, St. subgrande* var. *minor, St. elegantissimum, St. pulchrum, St. subscolopacinum, St. trifidum, St. cosmarioides, St. aristiferum* var. *indentatus, St. furcigerum* var. *armigerum* f. *gracillima.*

The following species that are rare in the world are discontinuously distributed in Japan. They show 60 species and two varieties. The writer shows these species in the table, together with their distribution :

Gonatozygon aculeatum var. *gracile*	Finland
Closterium subulatus var. *maius*	Germany
Cl. Ehrenbergii var. *atumidum*	Finland
Penium cylindrus var. *cuticulare*	England
P. exiguum var. *glaberrimum*	Germany
Pleurotaenium mamillatum	Australia
Cosmarium Logiense f. *expansa*	England
C. pseudarctoum var. *perminutum*	Norway
C. abbreviatum f. *pygmaea*	Switzerland
C. exiguum var. *subrectangulum*	England
C. retusum var. *angustum*	..
C. adoxum	..
C. pseudoexiguum var. *hexagonum*	Finland
C. tithophorum var. *minor*	Poland
C. maximum	Brazil
C. nitidulum var. *subundatum*	Switzerland
C. .. var. *pseudorectangulare*	..
C. orthostichum f. *subpolonica*	..
C. Hibernicum	England
C. lapponicum var. *undulatum*	Sweden
C. subcrenatum var. *Nordstedtii*	Germany
C. Braunii	..
C. binodulum	..
C. suborthogonum	Switzerland
C. varsoviense	Poland
C. Botrytis var. *depressum*	England
C. rectangulare var. *africanum*	Central Africa

C. monomazum var. *amazum*	Poland
C. Blyttii f. *lithuanica*	..
C. bigemma	..
C. occultum	Central Africa
C. viride f. *minor*	England
C. pachydermum var. *heptagonum*	Finland
Arthrodesmus phimus var. *occidentalis*	England
A. bifidus var. *truncatus* f. *suecica*	..
Euastrum subamoenum	Germany
E. binale var. *papilliferum*	Switzerland
E. diplostauron	Burma, Australia
Micrasterias tropica var. *polonica*	Finland, Poland
Staurastrum iotanum var. *tortum*	Sweden
St. pileatum var. *inflatum*	New Zealand
St. pachyrhynchum var. *convergens*	Poland
St. St. crenulatum var. *continentale*	Switzerland
St. laevispinum	England
St. mutilatum	Sweden
St. senarium var. *nigrae-silvae*	Germany
St. brevispinum f. *minima*	Switzerland
St. Gurgeliense	Austria
St. polymorphum var. *pygmaeum*	Finland
St. pseudobiretum	Australia
St. dorsidentiferum var. *ornatum*	Finland
St. retusum var. *boreale*	England
St. oxyrhynchum var. *truncatum*	Germany
St. anatinum var. *pelagicum*	England
St. Sebaldi var. *gracile*	Switzerland
St. orbiculare f. *subangulata*	..
St. paradoxum var. *nodulosum*	England
St. punctulatum var. *subproductum*	..
St. .. f. *minor*	..
St. furcatum f. *spinosa*	Finland
St. Reinschii f. *minor*	Sweden
St. cuspidatum var. *inflexum*	Switzerland

Some of the species among the so-called northern elements of Desmids are found in the high mountains of Japan and they and their distributions are shown in the table:

Species-name	Habitat
Cosmarium decedens	Mts. Daisetsu, Hakkoda, Gassan, Azuma, Komagatake, Hida mountains
C. parvulum	Mts. Daisetsu, Gassan, Azuma, Myoko, Hida mountains, Kirishima
C. obliquum f. *tatrica*	Mt. Daisetsu, Nasu volcanic range, Mt. Gassan, Oze, Hida mountains
C. notabile f. *arcticum*	Mt. Norikura
C. nasutum	Nasu volcanic range, Hida mountain Mts. Myoko, Shigakogen, Kujû
C. sphaeroideum	Mt. Kurobe-jiidaira
C. geometricum var. *suecicum*	Mt. Mitsumata-renge
C. cymatopleurum var. *tyrolicum*	Oze
C. petsamoense f. *simplicius*	Mt. Norikura
C. asphaerosporum var. *strigosum*	Mts. Hachimantai, Myoko
C. anceps	Mt. Norikura
Euastrum crassum	Mt. Daisetsu, Nasu volcani range, Mt. Naeba, Hida mountains, Kirigamine
E. cuneatum	Mt. Daisetsu, Nasu volcanic range, Mt. Gassan, Hida mountains
E. insulare	Mts. Hakkoda, Hachimantai, Akagi, Myoko, Naeba, Kirigamine, Hira
E. divaricatum	Mts. Daisetsu, Hakkoda, Komagatake, Gassan, Azuma, Oze
E. sublobatum	Mt. Daisetsu, Nasu volcanic range, Mts. Gassan, Naeba, Hida mountains
E. montanum	Mt. Daisetsu, Nasu volcanic range, Mt. Myoko, Hida mountains
Staurastrum hirsutum	Hida mountains, Mts. Daisetsu, Gassan, Myoko, Oze
St. wandae var. *brevispinum*	Mts. Daisetsu, Hachimantai, Gassan, Naeba, Azuma, Tateyama
St. pileolatum	Nasu volcanic range, Hida mountains, Mt. Gassan
St. aculeatum var. *ornatum*	Mt. Mitsumata-renge
St. Clepsydra	Hida mountains
St. .. var. *sibericum*	Hida mountains

As shown in the table, the main area of their distribution is in the northern Japanese Alps, the high mountains of Shinano and Etchu province, the Nasu volcanic ranges that form the watershed, especially in the northern part of the mountain range. In all of these areas the species are found in wet meadows or moor swamps of alpine and subalpine regions. In the northern Japanese Alps the species that are hitherto known only in north Europe are found in the alpine lake of Mt. Norikura (see table 8). Some of the northern species are often found in the moors in mountains or among the mosses on wet meadows supplied by springs. These cases are examples of the lowland that is climatically below subalpine conditions. Some instances are shown in the table:

Cosmarium microsphinctum	Mt. Kanpu, Mt. Akagi, Mt. Mikoto
C. cyclicum var. *arcticum*	Mt. Kanpu (Oga peninsula)
C. globosum var. *minus*	Mt. Akagi
C. nasutum	Kanazuka-mura, Hijiori-naga-numa
C. parvulum	Mt. Akagi, Ôhatayama of Mt. Kirishima
C. tetragonum var. *Lundellii*	Mt. Kanpu

The moors on high mountains are not rare in middle and northern Japan, but in south-western Japan the mountains are generally low, and the climate is mild, so that the moors do not exist except in confined places. The moor of Bôgatsuru on Mt. Kujû, central Kiushiu, a moor in the crater of Mt. Koshiki-dake, or a moor near Byakushi-ike in the Kirishima mountain group, and a moor on the summit of Mt. Miyanoura-dake, island of Yakushima, are particular instances under mild climate. But the members of Desmids found in these places coincide quite well with those of the moors in central and northern Japan, but the number of species decreases in moors in the western part of Japan. These facts seem to me to show that moors or peat-bogs widely prevail throughout the western part of Japan, and the moor-living species were more widely distributed in all marshes or peat-bogs of our country under the past cold climate, and remain up to the present in a confined place such as in a moor or a spring. There is the relic of a moor at the bottom of Aso caldera, called Kôga-muta, lying about 500 metres above the sea. The writer has found there some interesting northern species, such as *Cosmarium petsamoense*, and this species was originally found in alpine regions of northern Europe. The writer has found this species in the alpine lake of Mt. Norikura, Japanese Alps. It seems to be possible that the northern species are found in confined places, even in mild and lower places of western Japan.

Another remarkable fact concerning the distribution of Desmids is the finding of southern species which were not hitherto known in the temperate region of the northern Hemisphere. Southern species have been found only in tropical Asia, Malaysia, and North Australia, and some of these are found in various parts of Japan. The table shows the state of distribution concerning the number of species:

Hokkaido	17	Kansai	45
Northern Tôhoku	7	Shikoku	2
Southern Tôhoku	21	Chûgoku	0
Kanto	13	Kiushiu	22
Chûbu (Pacific side)	7		

The frequency of finding does not regularly decrease towards the north, but is fairly high in the central, and sometimes is rather high in the central or southern part of the Tôhoku district. The reason for the few found in south-western Japan is partly explained by the loss of the natural state of favourable habitats, because of the high utilization of land. In south-western Japan the southern elements of Desmids are often found in dystrophic, marshy waters, as in Imuta-ike; in northern Japan they often live in their mixed state with the northern element of Desmids. The fact that the northern and southern elements of Desmids are both found in the same water in a mixed state was frequently encountered in central Japan, especially in Lake Biwa and its neighbouring waters. In Lake Biwa, the oldest formation, the southern elements of Desmids, like the *Staurastrum leptocladum*, *Micrasterias mahabuleshwarensis*, and its var. *Wallichii*, live with northern elements of Desmids, like the *Staurastrum arctiscon*. Life in inland waters is mild and gradual in the variations of climatic condition, in comparison with land life, and this fact seems to explain the keeping of their life for both northern and southern elements of Desmids; moreover, disharmonic conditions in the nature of water, and the lack of nutrient substances are not suitable for the flagellous motile organisms, bacteria, and other competitors, but they are beneficial to desmid-life and protect them against the competition of flagellate organisms and bacteria. The Tôhoku district is richer in swamps in their natural state than other districts of Hondo. The districts in which the southern elements of Desmids are frequently found in richness, are south of the lower reaches of the Kitagami River and south of the upper reaches of the Mogami River. The northern districts, more than these districts, distinctly decrease in the number of species. The basin districts between the Debakyuryo and the central mountain range of the Tôhoku, rise markedly in temperature during summer, and the swamp-districts on the lower reaches of the Kitagami River are the northernmost limit affected by the warmness of the Black Current. The writer has found many species of southern elements of Desmids in the swamps near Kashima-cho, lying along the coastal plain of the Pacific. The summer temperature of these districts are higher than those of any other districts of Tôhoku. The districts north of these distinctly decrease in temperature. Judging from these facts it seems to be that a northern limit of distribution exists for desmids of the southern elements; however, the writer has data about the distribution of southern Desmids in some places of southern Hokkaido, like Tomakomai, Yûfutsu, and Shizukari along the sea-coast of the Pacific. In the past warm period of geological times, the southern elements of Desmids would probably prevail up as far as Hokkaido, and some of these are found remaining to this day. As mentioned above, the border line of distribution proposed by many authors is not so important in the case of desmid-distribution as is that of land-plants; distributional aspect of Desmids is rather remarkable in respect of the difference in the nature of the surrounding area of the algal habitat, especially in the nature of the dissolved substances of swamp-water.

The noteworthy genus containing the species of southern elements in our country are *Closterium, Pleurotaenium, Ichthyocercus, Cosmarium, Euastrum, Micrasterias,* and *Staurastrum.* The following table 18 shows the species and the state of their distribution, locally and abroad:

Table 18. Showing the species of austral elements and the state of their distribution locally and abroad

Habitat / Species name	Kiushiu	Chûgoku and Shikoku	Kinki	Kanto	Tôhoku	Hokkaido	Abroad
Closterium nematodes	+		+				Ceylon, Burma, India, Central China, Africa
Cl. Wallichii	+			+			India, Java
Pleurotaenium elatum	+						India, Ceylon, Clina, Java, Malay, Africa, Cuba
Pl. mamillatum	+						Australia
Pl. trochiscum			+				Ceylon, Java, Thailand, Burma, E. Africa, U.S.A.
Pl. verrucosum	+		+		+		India, Burma, Java, Australia, Africa, Cuba, U.S.A., Brazil
Pl. inermium			+				Bengal, Java, Macassar, Australia, Africa, S. America
Pl. Kayei			+	+	+		India, Ceylon, Java, Sumatra, South China, Australia

Table 18. (Continued)

Species name \ Habitat	Kiushiu	Chûgoku and Shikoku	Kinki	Kanto	Tôhoku	Hokkaido	Abroad
Euastrum ceylanicum	+		+	+	+		Ceylon, Sumatra
E. exile			+				Burma, Bali
E. indicum var. *capitatum*			+		+		Java
E. flammeum			+		+		Burma
E. dubium var. *tritum*			+		+		Burma
E. praemorsum			+	+	+		Sumatra, Australia, New Zealand, E. Africa
E. turgidum			+	+	+		India, Burma, Java, Sumatra, Banka, Australia
Micrasterias alata			+				Bengal, Java, Cuba
M. lux			+				Burma, India
M. foliacea			+	+	+	+	Burma, Ceylon, China, Africa, U.S.A.
M. Thomasiana var. *javanica*			+		+		Java
Cosmarium urceum			+	+			Malay
C. armatum	+						Burma
C. javanicum			+				Java
C. maculatum	+	+	+				India, Ceylon, Malay, South China
C. pandriforme	+		+		+		India
C. otus			+				Sumatra
C. bengalense	+		+	+	+		India, Java
C. obsoletum var. *sitvense*	+	+	+	+	+	+	Burma, Malay, Java, Sumatra, S. China
C. subturgidum f. *minor*	+	+	+	+	+		Thailand, Sumatra, China, Samoa, Australia, E. Africa
Xanthidium bengalicum			+	+			India, Ceylon
X. hastiferum var. *javanicum*			+	+			India, Burma, Java
Arthrodesmus curvatus			+		+	+	India, Sumatra, E. Africa
A. convergens f. *curta*			+				India
A. phimus					+		India, Ceylon
Staurastrum columbetoides	+		+	+			Ceylon
St. leptocladum	+		+	+		+	Burma, Central Africa, U.S.A.
St. unguiferum			+				India
St. saltans			+	+			India, Ceylon, Burma
St. subsaltans			+	+	+	+	Ceylon
St. Zahlbruckneri		+					Central China

Table 18. (Continued)

Species name \ Habitat	Kiushiu	Chûgoku and Shikoku	Kinki	Kanto	Tôhoku	Hokkaido	Abroad
St. ensiferum			+			+	India, Ceylon
St. javanicum						+	India, Java, South China
St. gyratum					+	+	Burma
St. triforcipatum					+	+	Ceylon
St. ceylanicum			+		+		Ceylon, Java
St. acanthastrum	+		+				Ceylon
St. limneticum var. *Burmense*	+						Burma
St. tauphorum var. *sumatranum*	+		+				Sumatra

It is difficult to-day to clear up the floristic relationships between Japan and neighbouring regions on the Desmid-flora, because of the lack of sufficient material in neighbouring countries. However, the writer has had an opportunity to study the material collected by Mr. S. NAKAO in the Nepal Himalaya, and also to study the collection of the Karakoram-Hindukush Expedition, made by Prof. S. KITAMURA and others. The Desmids obtained from these regions coincided quite well with the desmids of Japan and Europe. The desmids of the swamps near Kabul city, located at the centre of the desert region, are the same as those of Japan and Europe. The desmids found in the moor-swamps of the middle slope of the Himalaya (from 1500 metres up to 4000 metres above sea level) are the same members as the Japanese desmids, but the desmid-flora from the southern foot of the Himalaya (less than 1000 metres above sea level) are somewhat different from that of the upland Himalaya. Here, some of the elements of the Indo-Malayan region are led into the temperate Furasian flora of desmid. The northern limit of the Indo-Malayan region should probably be drawn at the southern foot of the Himalayan Mountain Range, and the centre of this region will probably be placed in Malaysia. The chief members of the Indo-Malayan elements found at the lowland area of the Himalaya are as follows: *Cosmarium javanicum*, *C. maculatiforme* var. *maior*, *C. obsoletum* var. *sitvense*, *C. pseudoconnatum* var. *subconstrictum*, *C. subturgidum* f. *minor*, *Euastrum substellatum*. The writer has prepared the following table on the distribution of the Japanese Desmids based on present knowledge. The mark ○ is boreal species; △ is austral species; × is confined to North and South America but not known as yet in any other regions; ⧺ is cosmopolitan species; + is widely distributed in the North Hemisphere but absent or rare in the South Hemisphere; * is new to Japan (to this writer); ※ is new to Asia.

Among 572 species, 239 are already known to exist in the cold zone of Eurasia (mainly Siberia) and circumpolar regions. The species common to the temperate zone of East Asia (exclusive of Japan) are 152 species; however the investigation of this region is incomplete, therefore the number of species will be highly increased in the future. The species common to the tropical zone of Asia are 328; 391 species are already known to exist in Europe. Furthermore 345 species are common to North America. Europe and North America are the clearest regions in the world as to Desmid-flora. The number of Japanese Desmids corresponds to about 60 % (or a little more) of the flora of Europe and North America. 187 species of Japanese Desmids are known to the Oceanic regions (mainly Australia and New Zealand); 229 species are common to Africa.

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Spirotaenia condensata	+	•	•	+	+	+	+	+	
Sp. obscura	+	•	•	+	+	•	+	•	
Mesotaenium De Greyi	•	•	•	+	+	•	+	•	*
M. .. var. *breve*	•	•	•	+	•	•	•	•	※ ○
M. .. var. *Borgei*	•	•	•	+	•	•	•	•	※ ○
M. macrococcum	•	•	+	+	+	•	•	•	*
M. chlamydosporum	•	•	+	+	+	+	•	•	
M. .. var. *violascens*	•	•	•	+	+	•	+	+	※
Cylindrocystis Brébissonii	+	•	+	+	+	+	+	+	*
Cyl. .. var. *Jenneri*	•	+	•	+	+	•	•	•	*
Cyl. .. var. *minor*	•	•	•	•	+	•	•	•	※
Cyl. crassa	•	+	+	+	+	•	+	+	*
Netrium digitus	•	+	+	+	+	+	+	+	⧺
N. .. var. *rectum*	•	•	+	+	•	•	•	•	*
N. .. var. *lamellosum*	+	+	+	+	+	+	+	+	* ⧺
N. .. var. *Nägelii*	+	•	•	+	+	+	+	+	
N. oblongum	•	+	•	+	+	+	+	+	*
N. .. var. *cylindricum*	•	•	•	+	+	•	•	+	
N. interruptum	•	•	•	+	+	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
N. interruptum var. *minor*	·	·	·	+	+	·	·	·	*
Gonatozygon monotaenium	+	+	+	+	+	·	·	+	
G. Brébissonii	+	+	+	+	+	·	·	+	
G. pilosum	+	+	+	+	+	·	·	·	
G. aculeatum	·	·	·	+	+	+	·	+	※
G. .. var. *gracile*	·	·	·	+	+	·	·	·	※
Penium silvae-nigrae	·	·	+	+	·	·	·	·	*
P. rufescens	·	·	·	+	+	+	·	·	※
P. margaritaceum	+	+	+	+	+	+	+	+	‡
P. exiguum	·	·	+	+	+	·	·	·	*
P. .. var. *glaberrimum*	·	·	·	+	·	·	·	·	※
P. cylindrus	+	·	·	+	+	+	+	·	*
P. .. var. *cuticulare*	·	·	·	+	·	·	·	·	※
P. substriatum	·	+	·	·	·	·	·	·	※
P. polymorphum	+	·	+	+	+	·	+	·	*
P. spirostriolatum	+	·	+	+	+	·	+	+	*
Roya cambrica	·	·	·	+	·	·	·	·	※
Closterium navicula	+	+	+	+	+	+	+	·	*
Cl. libellula	+	+	+	+	+	+	+	+	* ‡
Cl. .. var. *interruptum*	·	·	+	+	+	·	·	·	
Cl. .. var. *intermedium*	+	·	+	+	+	+	+	+	
Cl. acutum	·	+	·	·	·	·	·	·	*
Cl. .. var. *variabile*	·	·	·	+	·	·	·	·	※
Cl. gracile	+	+	+	+	+	+	+	+	* ‡
Cl. aciculare	+	·	+	+	+	+	+	·	*
Cl. toxon	·	+	+	+	+	·	·	·	
Cl. cornu	·	+	+	+	+	+	+	+	* ‡
Cl. .. var. *upsaliense*	·	·	·	+	·	·	·	·	※
Cl. littorale	·	+	·	+	+	·	·	·	*
Cl. sinense	·	+	·	·	·	·	·	·	*
Cl. strigosum	+	·	+	+	+	+	+	+	*
Cl. Johnsonii	·	·	·	·	+	·	·	·	※
Cl. idiosporum	·	·	·	+	+	·	·	·	※
Cl. lanceolatum	+	+	+	+	+	+	+	+	
Cl. Lunula	+	+	·	+	+	+	+	·	
Cl. subulatus var. *maius*	·	·	·	+	·	·	·	·	※
Cl. Baillyanum	+	·	+	+	+	·	+	+	
Cl. Pritchardianum	+	+	+	+	+	·	+	+	*
Cl. praelongum	+	+	+	+	+	+	·	·	*
Cl. lineatum	+	·	+	+	+	+	+	+	
Cl. .. var. *costatum*	·	·	·	·	+	·	·	·	※
Cl. attenuatum	·	·	+	+	+	·	·	·	*
Cl. setaceum	+	+	+	+	+	·	+	+	
Cl. Kützingii	+	+	+	+	+	+	+	+	*
Cl. rostratum	+	·	·	+	+	+	·	+	

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Closterium Ralfsii var. *gracilius*	•	•	+	+	•	•	+	•	
Cl. .. var. *hybridum*	+	+	+	+	+	+	+	+	
Cl. .. var. *novae-angliae*	•	•	•	•	+	•	•	•	※
Cl. venus var. *incurvum*	+	+	+	+	+	+	•	+	⧺
Cl. parvulum	+	+	+	+	+	+	+	+	⧺
Cl. .. var. *angustum*	•	+	+	+	+	+	•	+	*
Cl. tumidulum	•	•	+	+	+	+	•	+	*
Cl. calosporum var. *maius*	•	•	•	+	•	•	•	+	※
Cl. .. var. *brasiliense*	•	•	•	+	+	+	•	•	
Cl. dianae	+	+	+	+	+	+	+	+	⧺
Cl. .. var. *minus*	•	•	•	+	•	•	•	+	
Cl. .. var. *pseudodianae*	•	•	+	+	+	+	+	+	⧺
Cl. pusillum var. *minus*	•	•	•	+	•	+	•	•	※
Cl. moniliferum	+	+	+	+	+	+	+	+	⧺
Cl. .. var. *concavum*	•	•	•	+	•	•	•	•	※
Cl. Leibleinii	+	+	+	+	+	+	+	+	⧺
Cl. Ehrenbergii	•	+	+	+	+	+	+	+	⧺
Cl. .. var. *atumidum*	•	•	•	+	•	•	•	•	※
Cl. Wallichii	•	•	+	•	•	•	•	•	* △
Cl. abruptum	•	•	+	+	+	+	•	•	*
Cl. macilentum	+	+	+	+	+	+	+	•	⧺
Cl. .. var. *japonicum*	•	+	•	•	•	•	•	•	
Cl. Braunii	•	•	•	+	+	+	•	•	※
Cl. Ulna	+	+	+	+	+	•	+	•	
Cl. juncidum	+	+	+	+	+	•	+	•	⧺
Cl. intermedium	+	+	+	+	+	+	+	+	⧺
Cl. striolatum	+	+	+	+	+	+	+	•	⧺
Cl. .. var. *subpunctatum*	•	+	•	•	•	•	•	•	
Cl. acerosum	+	+	+	+	+	+	+	+	⧺
Cl. .. var. *tumidum*	•	•	•	+	•	+	•	•	
Cl. turgidum	+	•	•	+	+	+	•	+	*
Cl. .. var. *Borgei*	•	•	+	+	+	+	•	•	*
Cl. didymotocum	+	•	+	+	+	+	+	+	
Cl. angustatum	+	+	+	+	+	•	•	•	*
Cl. subjuncidiforme	•	•	•	+	•	•	•	•	※
Cl. costatum	+	•	+	+	+	+	•	•	*
Cl. .. var. *Westii*	•	•	•	+	+	•	•	•	※
Cl. Cynthia	+	+	+	+	+	+	+	+	* ⧺
Cl. .. var. *Jenneri*	+	•	+	+	+	+	•	+	*
Cl. .. var. *robustum*	•	•	+	+	+	•	•	+	*
Cl. nematodes	•	+	+	•	•	•	•	+	△
Cl. Archerianum	+	+	+	+	+	+	+	+	* ⧺
Spinoclosterium cuspidatum	•	•	+	•	+	•	•	•	* △
Pleurotaenium minutum	+	+	+	+	+	+	•	+	
Pl. .. var. *crassum*	•	•	•	+	•	+	•	+	
Pl. .. var. *gracile*	•	•	+	+	+	+	•	+	*

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Pl. minutum var. *latum*	•	•	+	+	•	•	•	•	*
Pl. .. var. *cylindricum*	•	•	•	•	•	+	•	•	* ×
Pl. .. var. *elongatum*	•	•	+	+	+	•	+	•	*
Pl. baculoides	•	•	+	+	•	•	+	+	
Pl. Trabecula	+	+	+	+	+	+	•	+	
Pl. .. var. *crassum*	+	+	•	+	•	•	•	•	
Pl. .. var. *rectum*	•	+	+	+	+	+	+	•	*
Pl. .. var. *elongatum*	•	•	•	+	•	•	•	•	※
Pl. indicum	•	•	+	•	+	+	+	+	△
Pl. annulare var. *zonatum*	•	+	•	•	•	•	•	•	※
Pl. repandum	•	•	+	•	+	•	•	•	
Pl. Ehrenbergii	+	•	+	+	+	+	+	+	
Pl. .. var. *curtum*	•	•	•	+	•	+	•	•	※
Pl. .. var. *crenulatum*	+	•	•	+	•	+	+	•	
Pl. .. var. *elongatum*	•	•	•	+	+	•	+	•	※
Pl. .. var. *undulatum*	+	+	+	+	+	+	•	+	*
Pl. eugeneum	•	+	+	+	+	+	•	+	*
Pl. truncatum	+	+	+	+	+	+	•	•	*
Pl. excelsum	•	•	+	•	+	•	•	•	
Pl. simplicissimum	•	•	•	+	•	•	•	•	※
Pl. .. var. *semiundatum*	•	+	•	•	•	•	•	•	※
Pl. subcoronulatum var. *africanum*	•	•	+	•	+	+	+	•	*
Pl. elatum	•	+	+	•	+	•	•	+	* △
Pl. .. var. *subundulatum*	•	+	•	•	•	•	•	•	※
Pl. tridentulum var. *breve*	•	+	•	•	•	•	•	•	※
Pl. mamillatum	•	•	•	•	•	•	+	•	* △
Pl. trochiscum	•	•	+	•	+	•	•	+	* △
Pl. verrucosum	•	•	+	•	•	•	+	+	△
Pl. nodosum	+	+	+	+	+	+	+	•	
Pl. inermium	•	•	•	•	•	•	+	•	
Pl. ovatum	•	•	+	•	•	+	+	+	* △
Pl. Kayei	•	+	+	•	•	•	+	•	△
Docidium baculum	•	+	+	+	+	+	•	+	*
D. undulatum	+	•	+	+	+	+	•	•	
Ichthyocercus longispinis	•	•	+	•	•	+	•	•	△
Tetmemorus Brébissonii	+	+	+	+	+	+	+	+	‡
T. .. var. *minor*	+	•	•	+	+	•	•	•	*
T. granulatus	+	+	+	+	+	•	+	•	*
T. laevis	+	•	+	+	+	+	+	+	
T. .. var. *tropicus*	•	•	+	•	•	•	•	•	△
Triploceras gracile	+	•	+	+	+	+	+	•	
Cosmarium Hibernicum	•	•	•	+	•	•	•	•	※
C. goniodes	•	•	•	•	+	•	•	+	※
C. magellanicum	•	•	•	•	•	+	•	•	※ ×

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Cosmarium oblongum	•	•	•	+	•	•	•	•	※
C. *diplosporum*	+	•	•	+	+	•	+	•	*
C. .. var. *major*	•	•	•	+	•	•	•	•	※
C. *cucurbitinum*	+	•	•	+	+	•	•	•	※
C. .. var. *minor*	•	•	+	+	+	+	•	•	
C. *Clevei*	+	•	+	+	+	•	•	+	*
C. *cucurbita*	+	+	+	+	+	•	+	+	*
C. .. f. *latior*	•	•	•	+	•	•	•	•	※
C. *parvulum*	+	•	+	+	+	+	•	+	*
C. *viride*	+	•	+	+	+	•	•	+	*
C. .. f. *minor*	•	•	•	+	+	•	•	•	※
C. *globosum*	+	+	+	+	+	+	•	+	
C. .. var. *subaltum*	•	•	•	+	+	•	•	•	*
C. .. var. *minus*	+	+	•	+	•	•	•	+	※
C. .. f. *minor*	+	+	•	+	•	•	•	•	*
C. *pseudarctoum*	+	•	+	+	+	•	•	•	
C. .. var. *perminutum*	•	•	•	+	•	•	•	•	※
C. .. var. *colorum*	•	+	•	•	•	•	•	•	※
C. *curtum*	+	•	+	+	+	•	+	+	
C. *subturgidum*	•	+	•	•	•	•	•	•	*
C. .. f. *minor*	•	+	+	+	•	•	+	+	△
C. *australe*	•	•	+	•	•	•	•	•	* △
C. *alpestre*	•	•	•	+	+	•	•	•	
C. *turgidum*	•	•	+	+	•	•	+	•	
C. .. var. *ovatum*	•	•	•	+	•	•	•	•	*
C. *connatum*	+	+	+	+	+	+	•	+	
C. *moniliforme*	+	+	+	+	+	+	+	+	╫
C. .. f. *punctata*	•	•	•	+	+	•	+	•	※
C. .. f. *pandriformis*	•	+	+	+	+	•	+	•	*
C. .. f. *elliptica*	•	•	+	•	•	•	•	•	* △
C. .. f. *elongata*	•	•	•	+	+	•	•	•	※
C. .. var. *subpyriforme*	•	•	+	+	+	•	•	•	*
C. *zonatum*	•	•	+	+	•	•	•	•	
C. *binerve*	•	•	•	+	•	•	•	•	※
C. *amoenum*	+	•	+	+	+	+	•	•	*
C. .. var. *alternans*	•	+	•	•	•	•	•	•	※
C. *nipponicum*	•	+	•	•	•	•	•	•	※
C. *pseudamoenum*	•	•	+	+	+	+	•	+	*
C. *elegantissimum*	•	•	+	+	+	•	•	•	*
C. .. f. *minor*	•	+	•	+	+	+	•	•	*
C. .. var. *simplicius*	•	•	•	+	+	+	•	•	※
C. *striolatum*	•	•	+	+	+	•	+	•	
C. .. var. *Nordstedtii*	•	•	+	•	•	•	+	•	* △
C. *praegrande*	+	•	+	+	+	•	•	•	*
C. *obsoletum*	+	+	+	+	+	+	+	•	
C. .. var. *sitvense*	•	+	+	•	•	•	•	•	* △
C. *maximum*	•	•	•	•	•	+	•	•	※ ×

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Cosmorium maximum var. *minor*	·	·	·	·	·	·	·	+	※
C. auriculatum	·	·	·	+	·	·	·	·	* △
C. Ralfsii var. *montanum*	+	·	·	+	·	·	·	·	* ○
C. dorsitruncatum	·	·	+	·	+	·	+	+	*
C. Lundellii var. *circulare*	·	·	+	·	·	·	·	·	* △
C. .. var. *ellipticum*	·	+	·	+	+	·	·	·	*
C. .. var. *corruptum*	·	·	·	+	·	·	·	·	*
C. circulare	·	+	+	+	+	+	·	+	
C. .. var. *minor*	·	·	·	+	·	·	·	·	
C. pachydermum	+	+	+	+	+	+	+	+	⧺
C. .. var. *heptagonum*	·	·	·	+	·	·	·	·	※
C. .. var. *aethiopicum*	·	+	·	+	·	·	·	+	
C. ocellatum	·	·	·	+	·	·	·	·	※
C. tithophorum var. *minor*	·	·	·	+	·	·	·	·	※
C. .. var. *depressum*	·	·	+	·	·	·	·	·	* △
C. taxichondriforme	·	·	·	+	·	·	·	·	※
C. taxichondrum	+	+	+	+	+	·	·	+	
C. .. var. *nudum*	·	·	+	·	+	·	·	·	*
C. .. var. *decachondrum*	·	+	·	·	·	·	·	·	
C. .. var. *magnum*	·	+	·	·	·	·	·	·	
C. undulatum	+	+	·	+	+	·	+	·	*
C. .. f. *minor*	·	·	·	+	·	·	·	·	※
C. .. var. *crenulatum*	+	·	+	+	·	+	·	·	※
C. .. var. .. f. *minor*	·	·	+	·	·	·	·	·	
C. .. var. *minutum*	+	+	·	+	+	·	·	+	*
C. obtusatum	+	+	·	+	+	·	·	+	
C. maculatum	·	+	+	·	·	·	·	·	△
C. javanicum	·	·	+	·	·	·	·	·	* △
C. pandriforme	·	·	+	·	·	·	·	·	* △
C. cucumis	+	·	+	+	+	+	·	+	*
C. subcucumis	+	·	·	+	+	·	·	+	
C. .. var. *elongatum*	·	+	·	·	·	·	·	·	
C. microsphinctum	+	·	·	+	+	+	·	·	* ○
C. petsamoense	·	·	·	+	·	·	·	·	
C. .. *formasimplicius*	+	·	·	·	·	·	·	·	* ○
C. speciosum var. *simplex*	+	+	·	+	+	·	·	·	*
C. contractum	+	+	+	+	+	+	+	+	* ⧺
C. .. f. *Jacobsenii*	+	·	·	+	+	·	·	+	*
C. .. var. *ellipsoideum*	+	·	+	+	+	·	+	+	*
C. .. var. *minutum*	·	·	·	+	·	·	·	·	※
C. inconspicuum	+	·	+	+	·	·	·	·	*
C. asphaerosporum var. *strigosum*	+	·	+	+	·	·	·	·	* ○
C. tenue	·	+	+	+	+	·	·	·	*
C. bioculatum	+	+	·	+	+	·	·	+	*
C. .. var. *depressum*	·	·	·	+	+	·	+	·	※
C. .. var. *hians*	·	·	·	+	·	·	·	+	※
C. tinctum	+	+	·	+	·	·	·	·	*

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Cosmarium tinctum var. *intermedium*	•	•	•	+	•	•	+	•	※
C. depressum	+	•	+	+	+	•	+	+	
C. .. f. *minuta*	•	•	+	+	•	•	•	•	*
C. .. var. *achondrum*	+	•	•	+	•	+	•	•	*
C. .. var. *minor*	•	•	•	+	•	•	•	•	※
C. .. var. *apertum*	•	•	+	•	•	•	•	•	*
C. .. var. *planctonicum*	•	•	•	+	•	•	•	•	※
C. subquadrans	•	•	•	+	+	•	•	•	※
C. bicardia	•	•	+	+	•	•	•	•	*
C. phaseolus f. *minor*	+	•	•	+	+	•	•	•	* ○
C. aversum	•	•	+	•	•	•	•	•	* △
C. pseudoprotuberans	+	•	+	+	+	•	•	+	*
C. .. var. *minor*	•	•	•	•	•	•	+	•	
C. .. var. *alpinum*	•	•	•	+	•	•	•	•	※
C. .. var. *angustius*	•	•	•	+	•	•	+	•	
C. .. var. *Borgei*	•	•	•	+	•	•	•	•	
C. urceum	•	•	+	•	•	•	•	•	* △
C. pokornyanum	+	+	•	+	+	•	•	•	
C. succisum	•	•	•	+	•	•	•	•	※
C. .. var. *hyalinum*	•	+	•	•	•	•	•	•	*
C. incertum	•	•	•	+	•	•	•	•	※
C. Hammeri	+	+	+	+	+	+	+	+	
C. .. var. *protuberans*	•	•	•	+	+	•	•	•	
C. .. var. *homalodermum*	+	•	+	+	+	•	•	•	*
C. Nymannianum	+	•	+	+	+	•	•	•	*
C. quadratulum	•	+	•	+	+	•	+	•	*
C. granatum	+	+	+	+	+	+	+	+	⧺
C. .. var. *subgranatum*	+	+	•	+	+	•	•	•	*
C. trilobulatum	•	+	•	+	+	+	+	+	※
C. .. var. *Printzii*	•	•	•	+	•	•	•	•	※
C. tetrachondrum	•	•	•	+	•	•	•	•	※
C. galeritum var. *minus*	•	+	•	+	•	+	•	•	
C. crispatum	•	+	•	•	•	•	•	•	※
C. subtumidum	+	•	•	+	+	+	+	+	*
C. .. f. *minor*	•	•	+	•	•	•	•	•	* △
C. .. var. *Klebsii*	+	•	•	+	+	•	•	•	*
C. .. var. *rotundum*	•	+	•	•	•	•	•	•	※
C. nitidulum var. *pseudorectangulare*	•	•	•	+	•	•	•	•	※
C. .. var. *subundulatum*	•	•	•	+	•	•	•	•	
C. variolatum var. *foraminum*	•	+	•	•	•	•	•	•	※
C. pseudopyramidatum	+	•	+	+	+	+	+	+	
C. .. var. *carniolicum*	•	•	•	+	•	•	•	•	※
C. .. var. *stenonotum* f. *minor*	•	•	•	•	+	•	•	•	※ ×
C. pseudonitidulum var. *validum*	+	•	+	+	+	•	•	+	*
C. pyramidatum	+	•	+	+	+	+	•	+	*
C. lapponicum var. *undulatum*	•	•	•	+	•	•	•	•	※
C. .. var. *granulatum*	•	+	•	•	•	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Cosmarium venustum	+	•	+	+	+	+	+	+	
C. .. f. *minor*	+	•	+	+	+	•	+	+	*
C. .. var. *brevius*	•	•	+	•	•	•	•	•	* △
C. Garrolense	•	+	+	+	+	•	•	•	*
C. sublatere-undatum	•	•	+	•	•	•	•	+	* △
C. cymatopleurum var. *Tyrolicum*	•	+	•	+	•	•	•	•	*
C. raeticum	•	•	•	+	•	•	•	•	※
C. fuseense	•	+	•	•	•	•	•	•	※
C. suborthogonum	•	•	•	+	•	•	•	•	※
C. crenatum var. *bicrenatum*	+	•	•	+	•	•	•	•	* ○
C. notabile f. *arcticum*	+	•	•	•	•	•	•	•	* ○
C. humile var. *striatum*	+	•	+	+	+	+	•	•	
C. Norimbergense	•	•	+	+	•	•	+	+	*
C. .. var. *depressum*	•	•	+	+	+	•	•	+	*
C. decedens	+	•	+	+	•	•	•	•	○
C. .. var. *sinuosum*	+	•	•	+	+	•	•	•	※
C. anceps	+	•	•	+	+	•	•	•	※○
C. qnadratum	+	+	•	+	+	•	•	•	*
C. .. f. *Willei*	+	•	•	+	•	•	•	•	* ○
C. tetragonum var. *Lundellii*	+	•	•	+	+	•	•	•	* ○
C. pseudobinerve	•	•	•	+	•	•	•	•	※
C. divergentiforme	•	+	•	•	•	•	•	•	※
C. plicatum	+	•	•	+	+	•	•	+	※
C. exiguum	•	•	+	+	•	+	+	+	*
C. .. var. *subrectangulum*	•	•	•	+	•	•	•	•	※
C. difficile var. *sublaeve*	•	•	•	+	+	•	+	•	※
C. synthlibomenum var. *montanum*	•	+	•	•	•	•	•	•	※
C. pericymatium	+	•	•	+	+	•	•	•	
C. minimum	•	•	+	+	•	•	•	+	*
C. .. var. *rotundatum*	•	•	•	+	•	•	•	•	※
C. pusillum	+	•	+	+	•	•	+	•	*
C. geometricum	•	•	•	+	•	•	•	+	※
C. .. var. *suecicum*	•	•	•	+	+	•	•	•	※○
C. angulosum	•	•	+	+	+	•	+	+	*
C. .. var. *concinnum*	+	+	+	+	•	+	+	+	*
C. rectangulare	+	•	•	+	+	•	•	•	
C. .. var. *africanum*	•	•	•	•	•	•	•	+	※△
C. pseudoexiguum	•	•	+	+	•	•	•	•	
C. .. var. *hexagonum*	•	•	•	+	•	•	•	•	※
C. .. var. *retusum*	•	+	•	•	•	•	•	•	※
C. Regnesi	+	+	•	+	+	+	+	+	
C. cymatonotophorum	•	•	•	+	•	•	•	•	※
C. staurastroides	•	•	•	+	•	•	•	•	※
C. bireme	•	•	+	+	+	+	+	•	*
C. adoxum	•	•	•	+	•	•	•	•	※
C. sinostegos var. *obtusius*	•	•	•	+	+	•	•	+	※
C. pygmaeum	+	+	+	+	+	+	+	•	

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Cosmarium prominulum var. *subundatum*	•	•	•	+	•	•	•	•	※
C. sexangulare	+	•	•	+	+	•	+	+	
C. .. f. *minima*	+	•	+	+	•	+	+	+	
C. abbreviatum	+	•	•	+	•	•	+	•	*
C. .. f. *minor*	•	•	•	+	•	•	•	•	※
C. .. f. *planctonicum*	+	•	•	+	•	•	•	•	※
C. .. f. *pygmaea*	•	•	•	+	•	•	•	•	※
C. .. f. *germanica*	•	•	•	+	•	•	•	•	※
C. subrectangulare	•	•	•	+	•	•	•	•	※
C. repandum f. *minor*	•	•	•	+	+	•	•	•	※
C. scopulorum	•	•	•	+	•	•	•	•	※
C. Clepsydra	•	+	•	+	+	+	•	•	
C. Regnellii	+	+	+	+	+	+	•	+	
C. .. var. *minima*	•	•	•	+	+	•	•	•	※
C. Meneghinii	+	+	+	+	+	+	+	+	⧺
C. .. var. *Reinschii*	+	•	•	+	•	+	•	•	
C. Braunii	•	•	•	+	•	•	•	•	※
C. impressulum	+	+	+	+	+	+	+	+	⧺
C. .. var. *octangularis*	•	+	•	•	•	•	•	•	
C. bengalicum	•	•	+	•	•	•	•	•	* △
C. laeve	+	+	+	+	+	+	+	+	⧺
C. .. var. *septentrionale*	+	•	+	+	+	•	•	+	
C. .. var. *octangularis*	+	+	•	+	+	•	•	+	*
C. .. var. *reniforme*	•	+	•	•	•	•	•	•	※
C. intermedium	•	•	•	+	+	•	•	•	※
C. margispinatum	•	+	•	•	•	•	•	•	※
C. monomazum var. *amazum*	•	•	•	+	•	•	•	•	※
C. quadrifarium f. *hexasticha*	+	+	+	+	+	•	+	•	
C. caelatum	+	•	•	+	+	•	•	+	※
C. .. var. *spectabile*	•	•	•	+	•	•	•	•	* ○
C. nasutum	+	•	•	+	+	•	•	•	○
C. cyclicum	+	•	•	+	+	•	•	•	※○
C. .. var. *arcticum*	+	•	•	+	+	•	•	•	* ○
C. Portianum	+	+	+	+	+	+	+	+	⧺
C. .. var. *nephroideum*	+	+	•	+	+	•	•	•	*
C. Logiense	•	•	•	+	+	•	•	•	※
C. .. f. *expansa*	•	•	•	+	•	•	•	•	※
C. sphalerostichum	+	•	•	+	+	+	•	•	※
C. varsoviense	•	•	•	+	•	•	•	•	※
C. geminatum	•	•	•	+	+	+	•	•	
C. novae-semliae var. *sibericum*	+	•	•	+	+	•	•	•	* ○
C. trachydermum	•	•	•	+	•	•	•	•	※
C. sphaeroideum	•	•	•	+	•	•	•	•	※
C. Wittrockii	+	•	+	+	•	•	•	•	*
C. perincisum	•	•	•	+	+	•	•	•	※○
C. reniforme	+	+	+	+	+	+	•	•	*

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Cosmarium .. var. *compressum*	•	•	+	+	+	+	+	•	*
C. .. var. *elevatum*	•	•	•	•	+	•	•	•	※ ×
C. granulatum	•	•	•	+	•	•	•	•	※
C. ornatum	+	•	•	+	+	+	•	•	*
C. orthostichum var. *pumilum*	•	•	•	+	+	•	•	•	※
C. .. var. *subpolonica*	•	•	•	+	•	•	•	•	*
C. polonicum	•	•	•	+	•	•	•	•	※
C. Sikhimense	•	•	+	•	•	•	•	•	* △
C. Botrytis	+	+	+	+	+	+	+	+	#
C. .. var. *depressum*	•	•	•	+	•	•	•	•	※
C. .. var. *subtumidum*	+	•	•	+	+	•	•	•	* ○
C. Raciborskii	•	•	•	+	+	•	•	•	※
C. punctulatum	+	+	+	+	+	+	+	+	#
C. .. var. *rotundatum*	•	•	+	+	•	•	•	•	
C. .. var. *subpunctulatum*	+	•	•	+	+	+	+	•	*
C. yezoensis	•	+	•	•	•	•	•	•	
C. bipunctatum	•	•	•	+	+	+	•	•	※
C. vogesiacum	•	•	•	+	•	•	•	•	※
C. dichondrum	•	•	+	•	•	•	•	•	* △
C. .. var. *subhexagonum*	•	•	+	•	•	•	•	•	* △
C. trachypleurum var. *cornutum*	•	•	•	+	•	•	•	•	※
C. .. var. *Nordstedtii*	•	•	+	•	•	•	•	•	* △
C. sexnotatum	•	•	•	+	+	•	•	•	※
C. furcatospermum	•	•	•	+	+	•		•	*
C. .. var. *Koreana*	•	+	•	•	•	•	•	•	*
C. quinarium	•	•	•	+	+	•	•	•	
C. otus	•	•	+	•	•	•	•	•	* △
C. tetraophthalmum	+	+	•	+	+	+	+	+	
C. ochthodes	+	+	•	+	+	•	•	•	
C. margaritiferum	+	•	•	+	+	+	+	+	
C. bigemma	•	•	•	+	•	•	•	•	※
C. vexatum	+	•	•	+	•	•	•	•	※
C. Sportella var. *subnudum*	•	•	•	+	+	•	•	•	※
C. eductum	+	•	•	•	•	•	•	•	※
C. occultum	•	•	•	•	•	•	•	+	※
C. Blyttii	+	+	+	+	+	+	+	+	* #
C. .. f. *lithuanica*	•	•	•	+	•	•	•	•	※
C. subcrenatum	+	+	+	+	+	+	•	+	*
C. .. var. *Nordstedtii*	•	•	•	+	•	•	•	•	※
C. subprotumidum	+	•	•	+	•	•	•	+	*
C. .. var. *Gregorii*	•	+	•	+	•	•	•	•	*
C. subalatum	•	•	+	+	+	•	•	+	*
C. subcostatum	+	•	+	+	+	•	•	•	*
C. .. f. *minor*	•	+	+	+	+	•	•	+	*
C. formosulum	+	+	•	+	•	•	•	+	*
C. .. var. *mesochondrium*	•	•	•	•	+	•	•	•	* ×
C. retusum var. *angustatum*	•	•	•	+	•	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
C. Malinvernianum	•	•	•	+	•	•	•	•	※
C. paulense var. *japonicum*	•	+	•	•	•	•	•	•	
C. armatum	•	•	+	•	•	•	•	•	＊△
C. binodulum	•	•	+	•	•	•	•	•	※△
C. binum	•	+	+	+	+	+	+	+	＊
C. subspeciosum	+	•	•	+	+	+	•	+	＊
C. .. var. *validum*	+	+	+	+	+	+	+	+	＊ ⧺
C. margaritatum	+	+	+	+	+	•	•	+	
C. .. f. *minor*	+	•	•	+	+	•	•	+	※
C. Quadrum	+	•	+	+	+	•	•	+	＊
C. .. var. *minus*	+	+	•	+	•	•	•	•	＊
C. pseudobroomei	•	+	+	+	+	+	•	+	＊
C. Ozense	•	•	•	•	•	•	•	•	
C. ungerianum var. *bohemicum*	•	•	•	+	•	•	•	•	※
C. latifrons	•	•	•	+	•	•	•	•	＊
C. pulcherrimum var. *boreale*	+	•	•	+	•	•	•	•	※○
C. obliquum f. *tatrica*	•	•	•	+	+	•	•	•	＊
Arthrodesmus Incus	+	•	+	+	+	+	+	•	＊
A. .. f. *minor*	+	•	+	+	+	+	+	•	＊
A. .. var. *validus*	•	•	+	+	+	•	•	•	＊
A. .. var *subhexagonum*	•	•	•	+	•	•	•	•	※
A. quiriferus var. *brevispinis*	+	•	•	•	•	•	•	•	＊
A. .. var. *brevispinis* f. *minor*	•	+	•	•	•	•	•	•	※○
A. crassus	•	•	•	+	+	•	•	•	※○
A. controversus	•	•	•	+	•	•	•	•	※
A. phimus	•	•	+	•	•	•	•	•	＊△
A. .. var. *occidentalis*	•	•	•	+	•	•	•	•	※
A. triangularis	+	•	+	+	+	+	•	•	
A. .. var. *minus*	•	+	•	•	•	•	•	•	
A. .. var. *latiusculum*	•	•	•	+	•	•	•	•	※
A. .. var. *acuminatum*	•	+	•	•	•	•	•	•	
A. extensus	•	•	•	+	+	•	•	•	※
A. .. var *retusum*	•	+	•	•	•	•	•	•	※
A. .. var. *malaccensis*	•	•	+	•	•	•	•	•	＊△
A. convergens	+	+	+	+	+	+	+	+	⧺
A. .. f. *curta*	•	•	+	•	•	•	•	•	＊△
A. curvatus	•	•	+	•	•	•	•	+	＊△
A. subulatus	•	•	+	+	+	+	•	+	※
A. .. var. *subaequalis*	•	•	•	+	•	•	•	•	※
A. .. var. *Nordstedtii*	•	•	•	•	+	•	•	•	＊△
A. rhomboides	•	+	•	•	•	•	•	•	※
A. octocormis	+	+	+	+	+	•	+	•	
A. bifidus v. *truncatus* f. *succisa*	•	•	•	+	•	•	•	•	※
A. impar	•	•	•	+	•	•	•	•	※
A. tenuissimum	•	•	•	+	•	•	•	•	※
A. trispinatus var. *japonicum*	•	+	•	•	•	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Xanthidium armatum	•	+	•	+	+	•	•	•	
X. inchoatum	•	•	•	+	•	•	•	•	※
X. apiculatum	•	•	+	•	•	•	•	•	△
X. bengalicum	•	•	+	•	•	•	•	•	△
X. japonicum	•	+	•	•	•	•	•	•	※
X. hastiferum var. *javanicum*	•	•	+	•	•	•	•	•	△
X. .. var. *curvispinosum*	•	•	+	•	•	•	•	•	
X. angulatum	•	•	+	•	•	•	•	•	△
X. cristatum var. *uncinatum*	•	+	+	+	+	•	•	•	*
X. .. v. *uncinatum* f. *depressa*	•	•	•	+	•	•	•	•	
X. .. var. *leiodermum*	+	•	+	+	+	•	•	•	
X. antilopaeum	+	+	+	+	+	+	•	+	
X. .. var. *laeve*	+	•	•	+	•	•	•	•	※
X. Burkilli	•	•	+	•	•	•	•	•	*
X. fasciculatum	+	+	+	+	+	+	•	•	
X. acanthophorum	•	•	+	+	•	•	•	•	
X. concinnum var. *Boldtiana*	+	•	•	+	+	•	•	•	*
X. .. var. *ozense*	•	+	•	•	•	•	•	•	※
X. .. var. *hexagonum*	•	•	•	+	•	•	•	•	
X. apiculiferum	•	•	+	•	•	•	•	•	※
Euastrum insulare	+	•	+	+	+	+	•	•	*
E. .. var. *silesiacum*	•	•	•	+	•	•	•	•	※
E. Lütkemülleri var. *carniolicum*	•	•	•	+	•	•	•	•	※
E. crassicole var. *incisum*	•	+	•	•	•	•	•	•	
E. montanum	+	•	•	+	+	•	•	•	○
E. binale	•	•	+	+	+	+	+	+	*
E. .. var. *parallelum*	•	+	•	•	•	•	•	•	※
E. .. var. *sectum*	+	+	+	+	+	•	•	+	*
E. .. var. *hians*	•	•	•	•	+	•	•	•	※
E. .. var. *minus*	+	•	•	+	+	•	•	•	*
E. .. var. *papilliferum*	•	•	•	+	•	•	•	•	※
E. .. var. *Koreanum*	•	+	•	•	•	•	•	•	
E. .. var. *Gutwinskii*	+	•	•	+	+	+	•	+	*
E. sublobatum	+	•	+	+	+	+	•	•	
E. .. var. *obtusatum*	•	•	+	•	+	•	•	•	* △
E. .. var. *Kriegeri*	•	•	+	+	•	•	•	•	*
E. diplostauron	•	•	+	•	•	•	+	•	△
E. acanthophorum v. *bigranulatum*	•	+	•	•	•	•	•	•	
E. exile	•	•	+	•	•	•	•	•	* △
E. excavatum	•	+	•	•	•	•	•	•	
E. attenuatum	•	•	+	•	+	+	•	•	*
E. pectinatum	+	•	•	+	+	+	•	+	*
E. ceylanicum	•	•	+	•	•	•	•	•	△
E. platycerum	•	•	•	+	•	•	•	•	
E. verrucosum	+	•	•	+	+	+	•	+	
E. germanicum	•	•	•	+	•	•	•	•	

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Euastrum spinulosum	•	+	+	+	•	•	•	+	
E. .. var. *inermius*	•	•	+	+	•	•	+	+	
E. gemmatum	+	+	•	+	+	+	•	+	*
E. glaberrimum	•	+	•	•	•	•	•	•	※
E. turgidum	•	•	+	•	•	+	•	•	△
E. ansatum	+	+	+	+	+	+	+	+	╫
E. .. var. *pyxidatum*	•	+	+	+	+	•	•	+	*
E. .. var. *javanicum*	•	•	+	•	•	•	•	•	* △
E. .. var. *dideltiforme*	+	•	•	+	+	•	•	•	※
E. cuneatum	+	•	•	+	+	•	+	•	
E. inerme	•	•	+	•	•	•	•	•	※
E. pingue	•	•	•	+	+	•	•	•	
E. indicum var. *capitatum*	•	•	+	•	•	•	•	•	* △
E. ampullaceum	•	•	•	+	+	•	•	•	
E. didelta	+	•	+	+	+	+	•	+	
E. .. var. *japonicum*	•	+	•	•	•	•	•	•	※
E. gnathophorum	•	•	+	•	•	•	•	•	* △
E. sinuosum var. *dideltoides*	•	•	+	•	•	•	•	•	*
E. .. var. *subjenneri*	•	•	+	•	•	•	•	•	* △
E. .. var. *germanicum*	•	•	•	+	•	•	+	•	*
E. .. var. *parallelum*	•	•	•	•	+	•	◦	•	* ×
E. .. var. *perforatum*	•	•	•	+	•	•	•	•	※
E. .. var. *gangense*	•	•	+	•	+	•	•	•	*
E. .. var. *scrobiculatum*	•	•	+	+	•	•	•	•	*
E. .. var. *aböense*	•	•	•	+	•	•	•	•	
E. .. var. *reductum*	+	•	+	+	+	+	•	+	*
E. Ozense	•	+	•	•	•	•	•	•	※
E. crassum	+	•	+	+	+	•	•	•	
E. pinnatum	+	•	•	+	+	+	•	+	* ○
E. oblongum	+	+	•	+	+	+	•	+	
E. affine	+	+	•	+	+	+	•	+	*
E. humerosum	+	•	+	+	+	•	•	•	
E. bilobum	•	•	•	+	•	•	•	•	※
E. elegans	+	•	•	+	+	+	•	+	
E. .. var. *pseudoelegans*	•	•	+	+	+	•	+	•	*
E. flammeum	•	•	+	•	•	◦	•	•	△
E. simplicius	•	•	+	•	•	•	•	•	* △
E. denticulatum	+	+	+	+	+	•	+	+	
E. .. var. *angusticeps*	•	•	•	+	+	•	•	•	*
E. subalpinum	•	•	•	+	•	•	•	•	
E. dubium	+	+	•	+	+	•	•	+	*
E. .. var. *tritum*	•	•	+	•	•	•	•	•	* △
E. subamoenum	•	•	•	+	•	•	•	•	※
E. Crameri	•	•	•	+	•	•	•	•	※
E. praemorsum	•	•	+	•	•	•	+	+	* △
E. divaricatum	+	•	•	+	+	+	•	•	*
E. bidentatum	+	•	•	+	+	+	•	•	

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Euastrum Turnerii	+	+	+	+	+	+	•	+	
Micrasterias pinnatifida	+	+	+	+	+	+	•	•	
M. decemdentata	+	•	•	+	•	•	•	•	
M. Crux-Melitensis	+	+	+	+	+	+	•	+	
M. radiata	•	•	+	+	+	+	•	+	*
M. alata	•	•	+	•	+	•	•	•	△
M. truncata	+	•	•	+	+	+	•	•	
M. Lux	•	•	+	•	•	•	•	•	* △
M. papillifera	+	+	•	+	+	+	+	•	
M. .. var. *glabra*	+	•	•	+	+	+	•	•	※
M. Murrayi	•	•	•	+	•	•	•	•	※
M. denticulata	+	•	•	+	+	+	•	•	
M. .. var. *angulosa*	+	•	•	+	+	•	+	+	*
M. .. var. *notata*	•	•	+	+	•	•	+	•	
M. .. var. *angusto-sinuata*	•	•	•	+	•	•	•	•	*
M. Thomasiana	•	•	+	+	+	•	•	•	
M. .. var. *javanicum*	•	•	+	•	•	•	•	•	* △
M. rotata	•	•	+	+	+	+	•	•	
M. sol	•	+	•	+	+	+	•	•	*
M. .. var. *ornata*	•	•	•	+	+	+	•	•	
M. apiculata	+	•	+	+	+	•	•	•	
M. foliacea	•	•	+	•	+	•	•	+	△
M. tropica var. *polonica*	•	•	•	+	•	•	•	•	
M. mahabuleshwarensis	•	•	+	+	+	+	+	+	*
M. .. var. *Wallichii*	•	•	+	+	•	•	•	•	
M. .. var. *asymmetricum*	•	+	•	•	•	•	•	•	※
Staurastrum capitulum	+	•	•	+	•	•	•	•	※
St. pileolatum	•	•	•	+	•	+	•	•	※○
St. minutissimum var. *convexum*	+	•	•	•	•	•	•	•	
St. muticum	+	•	+	•	+	+	+	•	*
St. subgrande f. *minor*	•	•	•	•	+	•	•	•	* ×
St. orbiculare	•	•	•	+	+	•	•	•	
St. .. var. *hibernicum*	•	•	•	+	+	•	•	•	※
St. .. var. *Ralfsii*	+	•	+	+	+	+	+	•	*
St. .. var. *depressum*	+	+	+	+	+	•	+	+	
St. .. var. *perdepressum*	•	+	•	+	•	•	•	•	
St. .. f. *subangulata*	•	•	•	+	•	•	•	•	※
St. coarctatum	•	•	•	+	•	•	•	•	※
St. .. var. *subcurtum*	•	•	•	+	•	•	+	•	※
St. insigne	+	•	•	+	+	•	•	•	* ○
St. Bieneanum	+	•	•	+	+	•	+	+	
St. pachyrhynchum	+	•	•	+	+	•	•	•	*
St. .. var. *convergens*	•	•	•	+	•	•	•	•	※
St. brevispinum	+	•	+	+	+	+	•	+	*
St. .. var. *minor*	•	•	•	+	•	•	•	•	
St. retusum var. *boreale*	•	•	•	+	•	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Staurastrum globosum	•	+	•	•	•	•	•	•	
St. cosmarioides	•	•	•	•	+	+	•	•	* ×
St. Zahlbruckneri	•	•	+	•	•	•	•	•	* △
St. trihedrale	•	•	•	•	+	+	•	•	※ ×
St. Clepsydra	+	•	•	+	+	+	•	•	* ○
St. .. var. *sibiricum*	+	•	•	+	+	•	•	•	○
St. sibiricum var. *occidentale*	•	•	•	•	+	•	•	•	※ ×
St. tortum var. *trigona*	•	•	•	•	+	•	+	•	※
St. subpygmaeum	•	•	•	+	•	•	•	•	※
St. Donardense	•	•	•	+	•	•	•	•	※
St. lapponicum	•	•	•	+	•	•	•	•	※
St. alternans	+	•	+	+	+	+	+	+	*
St. .. var. *subalternans*	•	•	•	•	•	•	•	•	※
St. dilatatum	+	•	•	+	+	+	+	+	
St. .. var. *hibernicum*	•	•	•	+	+	•	•	•	※
St. disputatum var. *sinense*	•	+	+	•	•	•	•	+	*
St. dispar	•	•	•	+	•	•	•	•	※
St. punctulatum	+	+	+	+	+	+	+	+	╫
St. .. var. *minor*	•	•	•	+	•	•	•	•	※
St. .. var. *Kjellmani*	+	+	•	+	+	•	•	•	*
St. .. var. *pygmaeum*	+	•	+	+	+	+	•	+	*
St. .. var. *subproductum*	•	•	•	+	•	•	•	•	※
St. granulatum	+	•	•	+	•	•	•	•	※
St. varians f. *truncata*	•	•	•	+	•	•	•	•	※
St. biannuliferum	•	•	•	•	•	•	•	•	※
St. asoensis	•	•	•	•	•	•	•	•	※
St. Dickiei	+	•	+	+	+	+	+	+	
St. .. var. *circulare*	•	•	+	+	+	•	•	+	*
St. .. var. *latum*	•	•	•	•	•	•	•	•	※
St. apiculatum	+	•	+	+	+	•	+	•	
St. connatum	•	+	+	+	+	+	•	•	
St. .. var. *rectangulum*	+	•	•	+	•	•	•	•	
St. .. var. *pseudoamericanum*	•	•	•	+	•	•	•	•	※
St. unguiferum	•	•	+	•	•	•	•	•	* △
St. megacanthum	+	•	+	+	+	+	•	•	*
St. .. var. *scoticum*	•	•	•	+	+	•	•	•	※
St. .. var. *minus*	•	•	•	•	•	•	•	•	※
St. dejectum	+	+	+	+	+	+	+	+	╫
St. .. var. *triangulatum*	•	•	+	•	•	•	•	•	* △
St. .. var. *patens*	•	•	•	+	•	+	+	•	※
St. curvatum	•	•	•	+	•	•	•	•	※
St. .. f. *biradiata*	•	•	+	•	•	•	•	•	* △
St. aristiferum var. *indentatum*	•	•	•	•	+	•	•	•	* ×
St. wandae var. *brevispinum*	•	•	•	+	•	•	•	•	※
St. erlangense	•	•	•	+	•	•	•	•	※
St. leptodermum var. *minor*	•	+	•	•	+	•	•	•	*

Regions / Species	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Staurastrum glabrum	•	•	•	+	+	•	•	•	※
St. O'Mearii	•	•	•	+	+	•	•	+	※
St. .. f. *parallela*	•	•	•	+	•	•	•	•	※
St. cuspidatum	+	+	+	+	+	+	+	+	
St. .. var. *divergens*	•	•	+	+	+	+	•	•	*
St. .. var. *inflexum*	•	•	•	+	•	•	•	•	※
St. subscolopacinum	•	•	•	•	+	•	•	•	※ ×
St. longispinum var. *bidentatum*	•	•	+	+	+	•	+	•	*
St. ensiferum	•	•	+	•	•	•	•	•	* △
St. bifidum	+	+	+	+	•	•	•	•	
St. trifidum	•	•	•	•	+	+	•	•	※ ×
St. quadrangulare	+	+	•	+	•	+	•	•	
St. lunatum	+	+	•	+	+	•	•	+	*
St. denticulatum	+	•	•	+	•	+	+	+	※
St. avicula	+	•	•	+	+	+	•	•	
St. .. var. *subarcuatum*	•	•	+	+	+	•	+	•	*
St. pileatum var. *inflatum*	•	•	•	•	•	•	+	•	※
St. subcruciatum	•	•	•	+	•	•	•	•	※
St. pseudobiretum	•	•	•	•	•	•	+	•	* △
St. Hystrix	•	•	•	+	+	+	•	•	
St. Simonyi	•	•	•	+	+	+	•	•	
St. .. var. *sparse-aculeatum*	•	•	•	+	•	•	•	•	※
St. echinatum	+	•	+	+	+	•	•	+	
St. Gurgeliense	•	•	•	+	•	•	•	•	※
St. subheteroplophorum v. *minor*	•	+	•	•	•	•	•	•	
St. subteliferum	•	+	•	•	•	•	•	•	
St. cristatum	+	•	+	+	•	•	•	•	
St. .. var. *japonicum*	•	+	•	•	•	•	•	•	
St. subdisparatum	•	+	•	•	•	•	•	•	
St. teliferum	+	•	+	+	+	+	•	+	
St. hirsutum	+	+	•	+	+	+	•	•	
St. gladiosum	•	+	+	+	+	•	•	•	*
St. polytrichum	+	+	+	+	+	+	•	•	*
St. pilosum	+	•	•	+	+	•	•	•	*
St. erasum	+	•	•	+	•	•	•	•	
St. subaciculiferum	•	+	•	•	•	•	•	•	※
St. aciculiferum	•	•	•	+	+	•	•	•	※
St. oxyrhynchum	•	•	•	+	•	•	•	•	
St. .. var. *truncatum*	•	•	•	+	•	•	•	•	※ ○
St. mutilatum	•	•	•	+	•	•	•	•	
St. spongiosum	+	•	•	+	+	+	•	•	*
St. .. var. *Griffithianum*	+	•	•	+	+	•	•	•	※
St. scabrum	+	•	•	+	+	•	•	•	*
St. monticulosum var. *bidens*	•	•	•	•	•	•	•	+	※
St. furcatum	+	+	+	+	+	•	+	+	
St. .. f. *spinosa*	•	•	•	+	•	•	•	•	※
St. .. var. *ozense*	•	+	•	•	•	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Staurastrum .. var. *subsenarium*	•	•	•	+	•	•	•	•	※
St. subavicula	+	•	•	+	•	•	•	•	*
St. submonticulosum	•	•	+	+	•	•	•	•	
St. ozense	•	+	•	•	•	•	•	•	※
St. .. var. *japonicum*	•	+	•	•	•	•	•	•	※
St. senarium	•	•	+	+	+	•	+	•	*
St. .. var. *nigrae-silvae*	•	•	•	+	•	•	•	•	※
St. forficulatum	+	•	•	+	+	•	+	•	※
St. .. var. *verrucosum*	•	•	•	+	•	•	•	•	※
St. gemelliparum	•	•	+	+	+	+	•	•	*
St. inconspicuum	+	•	+	+	+	+	•	+	*
St. laevispinum	•	•	•	+	•	•	•	•	※
St. brachiatum	+	•	•	+	+	•	+	+	
St. ceylanicum	•	•	+	•	•	•	•	•	* △
St. bacillare var. *obesum*	•	•	•	+	+	•	•	•	※
St. gyratum	•	•	+	•	•	•	•	•	* △
St. pulchrum	•	•	•	•	+	•	•	•	* ×
St. distentum	•	•	+	•	+	•	•	•	*
St. laeve	•	•	+	+	+	+	+	•	*
St. Reinschii f. *minor*	•	•	•	+	•	•	•	•	※
St. hexacerum	+	•	+	+	+	+	+	+	
St. polymorphum	+	+	+	+	+	+	+	+	‖
St. .. var. *pygmaeum*	•	•	•	+	•	•	•	•	※
St. .. var. *Grönbladii*	•	•	•	+	•	•	•	•	※
St. Haaboliense	•	•	•	+	+	•	+	•	※
St. pseudotetracerum	•	•	+	+	+	•	+	+	*
St. margaritaceum	+	+	+	+	+	+	+	•	*
St. .. var. *robustum*	•	•	+	+	•	•	•	•	*
St. crenulatum	•	•	•	+	+	•	•	+	
St. .. var. *continentale*	•	•	•	+	•	•	•	•	※
St. proboscideum	+	+	•	+	+	•	•	+	*
St. cyrtocerum	+	•	•	+	+	+	+	•	*
St. columbetoides	•	•	+	•	•	•	•	•	* △
St. iotanum	•	•	+	+	+	•	•	•	*
St. .. var. *longatus*	•	+	•	•	•	•	•	•	
St. .. var. *tortum*	•	•	•	+	•	•	•	•	※
St. tetracerum	+	+	+	+	+	+	+	+	‖
St. .. var. *subexcavatum*	•	•	•	+	•	•	•	•	
St. paeudoexcavatum	•	+	•	•	•	•	•	•	※
St. .. var. *binodulum*	•	+	•	•	•	•	•	•	※
St. excavatum	•	•	•	+	•	•	+	+	*
St. .. var. *planctonicum*	•	•	+	•	•	•	•	•	* △
St. Johnsonii	•	•	•	•	+	•	•	•	*
St. karasuensis	•	+	•	•	•	•	•	•	※
St. natator	+	•	•	+	+	•	•	•	※
St. inflexum	•	•	•	+	+	•	•	•	
St. Sebaldi var. *gracile*	•	•	•	+	•	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
Staurastrum subtilissimum	•	+	•	•	•	•	•	•	※
St. micron	•	•	•	+	+	•	•	•	※
St. .. var. *unidentatum*	•	+	•	•	•	•	•	•	※
St. acestrophorum	•	•	+	•	•	•	•	•	* △
St. paradoxum	+	+	•	+	+	+	+	+	
St. .. var. *parvum*	•	+	•	+	+	•	•	•	*
St. .. var. *longipes*	+	•	+	+	+	+	+	•	*
St. .. var. *nodulosum*	•	•	•	+	•	•	•	•	※
St. dentatum var. *gracilis*	•	+	•	•	•	•	•	•	※
St. dorsidentiferum var. *ornatum*	•	•	•	+	•	•	•	•	*
St. gracile	+	+	+	+	+	+	+	+	
St. .. var. *subtenuissimum*	•	•	•	+	•	•	•	•	※
St. .. var. *coronulatum*	+	•	•	+	•	•	•	•	
St˙ .. var. *ornatum*	•	•	+	•	•	•	•	•	
St. asteroideum var. *nanum*	•	+	+	+	+	•	•	•	
St. pentacrinum var. *trisetum*	•	+	•	•	•	•	•	•	※
St. longistipes	•	+	•	•	•	•	•	•	※
St. .. var. *nodulosum*	•	+	•	•	•	•	•	•	※
St. longiradiatum	•	•	+	•	+	•	•	+	*
St. .. var. *breviradiatum*	•	•	•	+	•	•	•	•	
St. oxyacanthum	+	+	•	+	+	•	•	•	*
St. pseudosebaldi	+	•	+	+	+	•	•	•	*
St. .. var. *simplicius*	•	•	•	+	•	•	•	•	※
St. elegantissimum	•	•	•	•	+	•	•	•	※ ×
St. zonatum var. *emarginatum*	•	+	•	•	•	•	•	•	※
St. .. var. *ceylanicum*	•	•	+	•	•	•	•	•	* △
St. asterias	•	•	+	•	•	•	•	•	* △
St. Arachne	+	•	•	+	+	•	+	+	
St. .. var. *curvatum*	•	•	•	+	•	•	•	•	※
St. dimazum var. *elegantius*	•	•	•	+	•	•	•	•	※
St. Duacense	•	•	•	+	•	•	•	•	※
St. sexcostatum var. *productum*	+	•	•	+	+	•	•	+	*
St. anatinum var. *pelagicum*	•	•	•	+	•	•	•	•	※
St. Manfeldtii	+	+	+	+	+	•	+	•	*
St. .. var. *annulatum*	•	•	•	•	+	•	•	•	※
St. tauphorum var. *sumatranum*	•	•	+	•	•	•	•	•	* △
St. Koidzumii	•	+	•	•	•	•	•	•	※
St. cerastes	•	•	•	+	+	•	•	•	※
St. triforcipatum	•	•	+	•	•	•	•	•	* △
St. acanthastrum	•	•	+	•	•	•	•	•	* △
St. limneticum var. *Burmense*	•	•	+	•	•	•	•	•	* △
St. tenuissimum	•	•	•	+	•	•	•	+	
St. aculeatum	+	•	+	+	+	+	+	•	
St. .. var. *ornatum*	+	•	•	+	•	•	•	•	※ ○
St. .. var. *processum*	•	+	•	•	•	•	•	•	※
St. contectum var. *involutum*	•	•	+	•	•	•	•	•	
St. vestitum	•	•	•	+	+	+	+	+	
St. .. var. *splendidum*	•	•	•	•	+	•	•	•	※

Species \ Regions	Circumpolar regions and Siberia	Temperate regions of East Asia	Tropical Asia	Europe	North America	South America	Australia and New Zealand	Africa	Remarks
St. bicoronulatum var. *simplicius*	•	•	•	+	+	•	•	•	※
St. Sebaldi	+	+	+	+	+	•	+	•	※
St. submanfeldtii	•	•	+	•	•	•	•	+	* △
St. subsaltans	•	•	+	•	•	•	•	•	* △
St. controversum	•	•	•	+	+	•	•	•	※
St. saltans	•	•	+	•	•	•	•	•	* △
St. leptocladum	•	•	+	•	+	•	•	+	△
St. tohopekaligense	•	•	+	+	+	•	•	+	
St. .. var. *trifurcatum*	•	•	+	+	•	•	+	•	
St. galeatum	•	•	+	•	•	•	•	•	* △
St. Hantzii var. *japonicum*	•	+	•	•	•	•	•	•	
St. leptacanthum	•	•	+	+	+	•	•	•	*
St. javanicum	•	•	+	•	•	•	•	•	* △
St. pinnatum var. *subpinnatum*	•	•	+	+	•	•	•	•	*
St. arcuatum	+	•	+	+	+	+	•	+	
St. furcigerum	+	+	•	+	+	+	•	•	*
St. .. f. *gracillima*	•	•	•	•	+	•	•	•	※ ×
St. .. var. *eustephanum*	•	•	•	+	+	•	+	•	※
St. sexangulare var. *crassum*	•	•	+	+	•	•	•	•	
St. .. var. *subglabrum*	•	•	+	•	•	•	•	•	△
St. arctiscon	+	•	+	+	•	•	•	•	
Cosmocladium constrictum	•	•	•	+	+	•	•	•	*
C. saxonicum	+	•	•	+	+	•	•	•	
Spondylosium planum	+	•	+	+	•	•	•	•	
Sp. pulchellum	+	•	+	+	•	•	+	•	※
Sp. moniliforme	•	•	+	+	•	•	•	•	*
Hyalotheca undulata	•	•	+	+	+	•	•	•	*
H. mucosa	•	•	•	+	+	+	+	+	*
H. dissiliens	+	+	+	+	+	+	+	+	* ⧺
H. .. var. *minor*	•	•	•	+	•	•	•	•	※
H. .. var. *tatrica*	•	•	•	+	+	•	•	•	
H. indica	•	•	+	•	•	•	•	•	
Gymnozyga moniliformis	+	+	+	+	+	+	+	+	⧺
G. .. var. *gracilescens*	•	+	+	+	+	+	•	•	*
Desmidium coarctatum	•	•	+	+	+	•	+	•	
D. Swartzii	+	+	+	+	+	+	+	+	⧺
D. aptogonum	•	+	+	+	+	+	+	+	
D. Baileyi	•	•	+	•	+	•	•	+	
D. pseudostreptonema	•	•	+	+	•	•	+	•	*
Sphaerozosma excavatum	+	+	+	+	+	+	+	+	⧺
Sph. granulata	+	+	+	+	+	+	•	+	
Sph. .. var. *trigranulatum*	•	•	•	+	•	•	•	•	※
Sph. aubertianum	•	•	•	+	+	•	+	•	※
Sph. .. var. *Archeri*	+	•	+	+	+	•	+	•	*
Sph. vertebratum	•	•	+	+	+	+	•	•	*
Sph. .. var. *latius*	•	•	•	+	•	•	•	•	
Onychonema filiformis	+	•	+	+	+	+	+	•	
O. laeve	+	•	+	+	+	+	•	•	

Summary and conclusion

1. The present study deals with the Desmid-flora of Japan Proper, based upon the collections made by the present writer himself. The total number of species treated in the present study is 572 species, 256 varieties, and 38 forms belonging to 27 genera. Among these, 24 species, 39 varieties, and one form are new to science, and a new addition to the Japanese Desmid-flora are 377 species, 205 varieties, and 27 forms.

2. Japanese Desmid-flora characteristically comprises many austral species, mainly distributed in the Indo-Malayan regions, and these number 85 species, one variety, and corresponded to 15 % of the entire specics of the flora; while boreal species are fairly few in number of species and are confined to distribution in the moor-bogs of the upland, or the relic-moors of lowlands, and are sometimes found in springs. These boreal species number 30, 3 varieties, and correspond to 5 % of the entire species of the flora. The species showing a peculiar distribution confined to the circum-polar regions are very few in number, and are found in a boggy springs of the uplands.

3. The species showing a sporadical distribution (or rare species of the world) are also found in our country, but these are not truely "rare" species, nor are they characteristic of our Desmid-flora. These species will probably have their names removed from the "rare" rank by progress of investigations in neighbouring countries.

4. It is impossible to settle upon any definite border line, or to divide distributional areas based on the composition of the Desmid-flora, but there is some inclination to do this in the distribution of the austral species. The chief areas comprising the austral species extend towards the neighbourhood of the lower reaches of the Kitagami River on the coastal side of the Pacific, and extend towards the basin districts of Yamagata Pref.; while some species are distributed far beyond these areas, up as far as Hokkaido.

5. In the Kansai district, especially in Lake Biwa and its surrounding area, many species of austral and boreal form are found in a mixed state in the same waters (such as Fuse-ike, Shinohara-ike and Lake Biwa). Lake Biwa is an origination of the old formation and has many plankton-desmids. Its basin-area had expanded wider than its present state, and had included the present surrounding areas in the lake-basin. The special richness of the plankton-desmid in Lake Biwa, more than in other lake waters of Japan, is difficult to explain based on chemical composition, but it is probably due to a long history since geological times.

6. The richest areas for Desmids are, in general, confined to natural

ponds or swamps of old formation and their floral compositions are essentially similar to each other in spite of their geographical position. The regional-flora of Desmids would, until quite recently, be similar from Kiushiu to Hokkaido, but the characteristic features of distribution were destroyed, and they lost their natural state by the rapid cultivation of land. These seem to exist in the division of the distributional areas, however the compositions of the swamps, ponds, and moor-bogs in their natural circumstances, are similar to each other, from the study of the remains found in natural ponds and swamps.

7. It is difficult to explain the state of distribution of Desmids, based upon the difference in the chemical compositions of inland waters of Japan, however the balanced state of dissolved substances are probably important to desmid-life, but any unbalance due to excess substances will be sometimes injurious for desmids, and will operate as a limiting factor. A low content of calcium in the waters is said to be generally beneficial for Desmids. This is certainly true in the distribution of Japanese Desmids, where the calcium content of Japanese inland waters is small (not beyond 10 mg per litre), but a number of species in waters of various parts of the country is not always rich in Desmids. The high content of calcium in the waters is confined to special places, and the Desmid-flora in such places is of course very poor in number of species. The calcium content of 4–8 mg per litre is often rich in desmids under the condition that the calcium content is balanced with other chemical constituents, especially where the chloride-content is more than the amount of calcium, or at least equal to the same amount. However it is injurious and poor in desmids, when the calcium content is only in excess of the other substances. The excess content of chloride is of course injurious to desmids, and the paucity of desmids in the ponds and swamps of the coastal plain regions is due partly to this reason and partly to the shorter history of their formation.

8. A long time seems to be necessary to establish their life in new habitats, even if the Desmids have had the opportunity of having been transported to new habitats by various methods. The inland lakes of Japan vary in their age of formation, and the true planktonic desmids in these lakes are usually small in number of species, especially in crater-lakes and dammed lakes, but are fairly greater in Lake Biwa, because of the long time of their formation, probably since the Triassic Period. The distributional state of Desmids are a long historical product, and the group of Desmids where have no progressing species adapted positively to new habitats; in short, the Desmids would probably vanish by competition against other organisms in cultivated lands.

Plate LIII.

1. *Staurastrum arctiscon* (EHRENB.) LUND. 386
2. *Desmidium pseudostreptonema* W. & G. S. WEST 397
3. *D. aptogonum* BRÉB. 396
4. *D. Baileyi* (RALFS) NORDST. 397
5. *D. Swartzii* AG. 396
6. *Sphaerozosma aubertianum* WEST 400
7. *Desmidium coarctatum* NORDST. 395
8. *Sphaerozosma granulatus* ROY & BISS. var. *trigranulatum* W. & G. S. WEST 400
9. *Cosmocladium constrictum* ARCH. 387
10. *C. saxonicum* DEBARY 388
11. *Hyalotheca dissiliens* (SM.) BRÉB. 391

12, 13. *H.* .. f. *bidentula* NORDST. 392

14. *H.* .. f. *tridentula* NORDST. 392
15. *H.* .. var. *minor* DELP. 392
16. *H.* .. var. *tatrica* RACIB. 392
17. *H. indica* TURNER 393

18, 19. *H. mucosa* (MERT.) EHRENB. 391

20. *Sphaerozosma aubertianum* WEST var. *Archeri* (GUTW.) W. & G. S. WEST 400
21. *Spondylosium planum* (WOLLE) W. & G. S. WEST 388
22. *Sphaerozosma excavatum* RALFS 398
23. *S. granulatus* ROY & BISS. 399
24. *S. vertebratum* (BRÉB.) RALFS 401
25. *Spondylosium pulchellum* ARCH. 389

1—25. (×550)

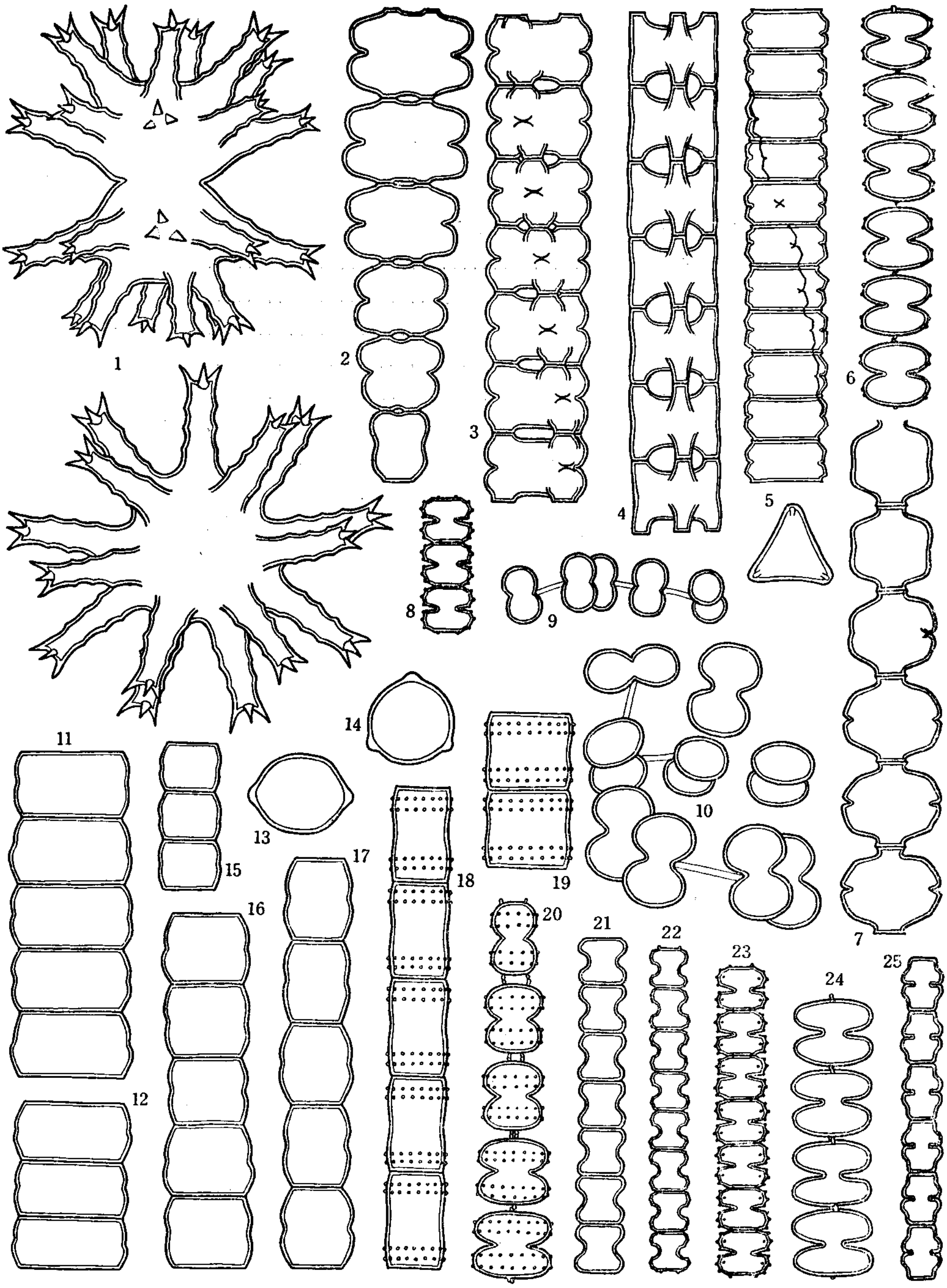

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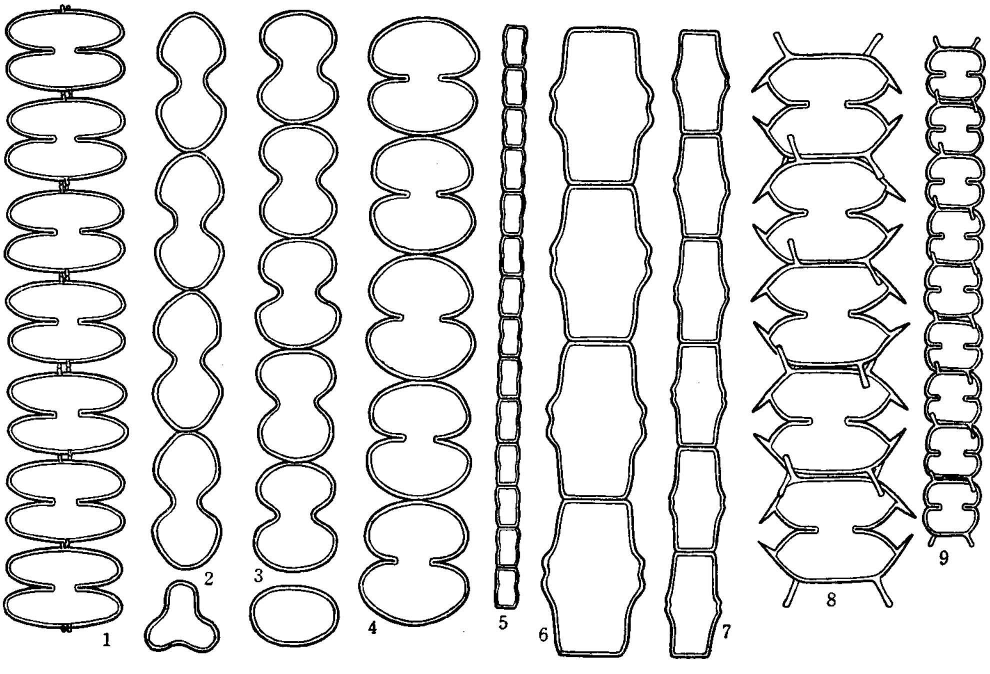
Plate LIV.

1—9. ($\times 550$)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